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ON CERTAIN PHENOMENA

BELONGING TO THE CLOSE OF

THE LAST GEOLOGICAL PERIOD

AND ON THEIR BEARING UPON

THE TRADITION OF THE FLOOD

BY

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PREFACE

THE geological phenomena which suggested to me the hypothesis of a comparatively recent Submergence of Western Europe and of the Mediterranean coasts are described in papers read before the Geological Society in 1892,[1] and before the Royal Society early in 1893.[2] In those papers I confined myself to the purely geological questions; but as the hypothesis seemed to have a bearing upon questions relating to the Tradition of the Flood, I brought the subject to the notice of the Victoria Institute, in a paper which that Society has done me the honour to publish in their *Journal of Transactions* for 1894. It was not, however, possible to include within the compass of one evening's communication the many considerations connected with so wide a subject, which are

[1] "On the Raised Beaches and 'Head' or Rubble-drift of the South of England, etc.," *Quart. Journ. Geol. Society*, vol. 48, p. 263.

[2] "On the Evidences of a Submergence of Western Europe and of the Mediterranean Coasts at the close of the Glacial Period," etc., *Phil. Trans.*, for 1893.

therefore given at greater length in the following pages.

It may be thought by many of my geological friends that the hypothesis put forward involves too much catastrophic action. There is however, I consider, sufficient evidence to warrant the inferences I have drawn from the facts described, as well as reason to believe that the Tradition could not have had its origin otherwise than in an event of a very exceptional and extraordinary character—far more so than any that could have resulted from ordinary river floods. It seemed also to me impossible to account for the special geological phenomena on which the hypothesis is based by any agency of which our time has afforded us experience, so that we must judge of the cause of their origin by the results as they are now to be observed and interpreted, and not by any assumed postulates. Many explanations have been suggested for parts, but none have embraced the whole of the geological phenomena. Led to suspect the possibility of an unusual form of water agency, I put the case of a Submergence and subsequent Emergence hypothetically, and found that the consequences which resulted agreed in a remarkable manner with the observed facts. In any hypothesis framed to meet the incidents recorded in the Narrative of the Flood, care must be taken to separate those statements which conform to natural causes

and laws from those that are due to the human colouring in which the extraordinary event has become enveloped. The inclusion of the impossible has only served to throw doubt on those portions of the narrative which are possible. Even with the omission of the former, there is much that is difficult to explain and which requires further research. I am however encouraged, as the hypothesis satisfies so many of the conditions of the problem, to hope for a solution favourable to the interpretation herein suggested. Much more time and many more workers are however required for the investigation of the many questions involved in the inquiry.

In any case, if the connection of the Tradition with the phenomena described in these pages fails to find confirmation, their study from a geological point of view may, I trust, be advanced by the collocation of the facts which I have grouped together under the designation of the "Rubble-drift."

As the subject is necessarily technical, I have given only such few geological details as are needed for the argument, in a manner I trust to be understood by those who have but a slight acquaintance with that science. Geologists will find the fuller details and discussion of the facts in the several papers referred to in the text.

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§ 1. Preamble

One of the subjects on the borderland between Natural Science and Theology which has long given rise to discussion is the story of the Noachian Deluge. Early in the century the Biblical account was accepted literally as an article of faith, alike by geologists and theologians, and for a time the aim of the geologist was directed to an endeavour to reconcile the Narrative of the Pentateuch with the facts of Geology. This signally failed, as the attempts were made to account for fable as well as for fact. The writers endeavoured to explain not only the destruction of life,[1] but also such physical impossibilities as the universality of the Deluge, and the story of the Ark and its contents. These latter

[1] They looked upon the remains of the great extinct mammalia whether found in caves or in valley-drifts as proofs of the Flood, but did not admit that man was their contemporary.

questions, which have been fully dealt with by other writers, I may pass over, and confine myself to the question whether Geology furnishes evidence in support of a flood of the magnitude and disastrous consequences of the one typified in the ancient narratives.

Another cause of failure arose from the circumstance that these attempts were made in the infancy of Geology, when the phenomena connected with the later changes on the surface of the Globe—those connected with the so-called Drift or Quaternary deposits—were little understood, or, I may say, not a little misunderstood. Not only so, but the special class of Drift (the Rubble-drift of the author) which alone relates to this particular branch of inquiry consists of such variable and often obscure deposits that their significance has escaped general recognition. Besides this, the phenomena are localised within such narrow limits that wide tracts of country may be traversed without meeting with an exhibition of the Rubble-drift. Large areas have been swept bare, and it is only where a lodgment has been effected in some hollows or cavities, or on slopes, that the deposits become at all important. Their diversities of character have also led to their being considered as belonging to unrelated phenomena, and each form of this drift has received its separate explanation. It has been my object to show that they may all be grouped under one head and admit of the same one explanation of their origin.

It is now known that the Tradition of the Noachian

Deluge is of far older date than the version given in the Hebrew narrative. This seems to have been adapted from the Babylonian records with such alterations as would fit it to a different religious belief. Accordingly the Jewish writers have substituted for the polytheism of the Chaldeans the monotheism of their own countrymen. Another important difference is that, whereas in the account in Genesis only Noah and his family of seven persons were saved, the Babylonian records state that Sisothros (or Khasisadra—Noah of the Bible), with *all his slaves and concubines and the sons of the people,* escaped. In the one case, again, the duration of the flood is made longer than in the other, and the waters are said to have covered the highest mountain tops; whereas in the other, the high mountains are said to have remained above the waters. The other points of difference are slight, and such as might arise from the different handling of the same story.[1]

Granting that the tradition had a foundation in fact, long ages must have passed before even the older account of the catastrophe was put on imperishable record by the style engravers of Babylonia, during which time the story could easily have received the figurative construction in which it has come down to us. Nor is it difficult to distinguish what may be fact from what is fable. That an inundation, from whatever cause, of great extent and depth, yet leaving the higher ground and hills uncovered,

[1] See Appendix A for further particulars of the Babylonian narrative.

took place, is a possible contingency; and this, while destructive to large populations in the lower lands and plains, was compatible with the survival of others who escaped to places that remained unsubmerged, whence, after the fall of the waters, they repeopled the land. This reading would account for the rapid growth of the new populations. In this case also it is obvious that not only the animals of the plains which fled to the higher grounds, but also that the flora as well as the fauna of those countries, would, with few exceptions, be preserved.[1]

According to the Tradition, the flood was of comparatively short duration, and this statement agrees with the geological conditions, in that there is an entire absence of such sedimentary deposits as must have been formed had the waters rested long on the land. As the other details of the story do not touch on Natural Science, we need not pursue the subject further in this direction.

It has frequently been asserted of late years that there is no geological evidence of a deluge having passed over the surface of the land at the period recorded. This may be accounted for partly by the reasons given above, and partly by the circumstance that, since Buckland wrote, the issues in question have been considered closed and the subject neglected, as most of the phenomena described by him have been explained in other ways.

The explanation I have suggested as a possible cause

[1] It may be a question whether, at the same time, there was not likewise a great change of climate.

for the origin of the Tradition has been met by a preliminary objection, which I cannot however admit to be valid, as it is based upon the assumption of Uniformity *in degree in all time*.[1] According to this the time measure for all great changes of level should be limited to about 2½ feet in a century, so that the more rapid movements involved on our hypothesis would be thought impossible.[2] It is clear, however, to us that up to the very date of the submergence described in the following pages, the crust of the earth was in a very mobile state, for that it underwent shortly before that event many considerable upheavals is amply proved by the presence of Raised Beaches with shells of existing species at elevations of 10 feet, 100, and up to 600 feet or more. What the exact rate of these upheavals may have been it is impossible to determine, but that they come within a short range of geological time is clearly shown by the circumstance that the species of shells are recent throughout. I cannot, therefore, consider that objection a bar to the proposed hypothesis.

Let us now see how far the consequences of a deep submergence agree with the geological phenomena described in previous memoirs, and briefly resumed in these pages. As the waters crept slowly over the

[1] Uniformity of *kind* (or law) cannot be questioned, but uniformity of *degree*, which is the essential condition of the modern doctrine of Uniformitarianism, stands on a very different footing. This is a question I have discussed at some length, in the *Nineteenth Century* for October 1893, under the title of *The Present Position of Geology*. See also the author's *Geology*, vol. i.

[2] See Appendix B.

land, we may assume that all the animals, of whatsoever description, fled before the advancing flood, and sought safety on the higher unsubmerged grounds and hills, though many were overtaken and perished. At the same time there is reason to believe that the unequal strains produced by the great earth movement disturbed and rent the rocks, for gaping fissures were formed,[1] especially where strong divisional planes in the strata favoured vertical disruption.[2] Thus, the hills of Devonian limestone near Plymouth (*postea*, p. 26); the Cretaceous and Jurassic limestones of the South of France (p. 37), and Italy, and of the Rock of Gibraltar; the Tertiary and Cretaceous limestones of the northern coasts and Islands of the Mediterranean; together with the limestone ranges of the North African coast (p. 59), were rent in many places and to variable depths. As the flood waters increased in depth, and the greater became the destruction of animal (and some human) life, decaying bodies and detached limbs would be scattered over the submerged surface, more particularly on those spots where the animals had ineffectually sought refuge. As the land emerged again, sometimes, as we shall show, slowly, and at others more rapidly, the effluent waters swept into the open fissures the *débris* of the old land surface, together with the remains of the drowned animals, with more

[1] Had the fissures been of older date remains of an older fauna would have been preserved (*postea*, p. 68).

[2] The surface waters had, in this case, little or nothing to do with the formation of these fissures.

or less force and violence. Nor could this have been the work of long time, for the entombed bones, though much broken, are singularly fresh, and the time was not sufficient to allow of the formation of any marine sedimentary deposits.

In the same way that the surface rubble was swept into fissures, so when any hollows or depressions were present on the surface it lodged there, as for example that in the old gully or ravine on the slope of the Chalk hills above Didcot. Where not caught, as it were *in transitu*, the rubble was swept down to lower levels and formed banks of breccia on the slopes, and at the base of the hills, as in the instances quoted at Mont Genay (p. 36), Mentone (p. 36), and Gibraltar (p. 45). At this latter place the force of the effluent current is well exemplified, it having carried down from the heights above a brecciated mass of rubble 100 feet thick with blocks 12 feet or more in diameter. It is in a breccia of this character, situated at the foot of the hills at the back of Palermo, that the extraordinary mass of Hippopotami bones occurs (p. 50).

The most distinct form in which this detrital rubble is exhibited in England is where it has been carried over the old cliffs which fringed the coast previous to the submergence. This line of cliffs differed little in its position from that of the existing line, but the land then stood lower, so that the beach which fronted those cliffs now stands 10 to 30 feet above the present beach, and for that reason is termed a "Raised Beach." As the land *débris* shot over the

old cliffs, it fell on the "Raised Beach," and when the cliffs were not too high this mass of rubble entirely masked them, and formed a surface flush with the surface of the ground above the cliff. We find in this Rubble not only the remains of the animals which were overtaken and destroyed by the waters, but even the delicate land shells which lived in the grass and amongst the fallen leaves of the old land surface.

There are well-known examples of this rubble, or as it is termed "Head," in the cliffs at East Brighton[1] (p. 24), Portland Bill (p. 23), Hope's Nose near Torquay, Baggy Point near Barnstaple, Newslade in Gower, besides a number of other places which are described in my paper on the Raised Beaches of the south of England. On the French coast there is a fine exhibition of this rubble with an underlying Raised Beach on the eastern slope of the Chalk promontory of Cape "Blanc Nez" near the village of Sangatte, four miles west of Calais (p. 32). Besides some remains of the great extinct Mammalia, *land shells*, which have not yet been noticed in the Brighton cliff, are common here, together with a few *palæolithic* flint implements—the work of early Man. The same features are repeated, but not so distinctly, on other parts of the French coast.

Amongst places of especial interest are the Channel Islands, each of which is surrounded by the remnants of a Raised Beach with the accompanying "Head." As no remains of the quaternary Mammalia have been found there either in the "Head" or inland in the Loess,

[1] Now in greater part hidden by the sea wall.

it may be a question whether these Islands were inhabited by them at the time of the submergence. The position of this "Head" all round these Islands shows very clearly that the sweep of the *débris* was from the centre of the islands outwards, or such as would result from the flow off of a body of water during the emergence of the islands (p. 43). The later action of the sea has removed considerable portions both of the "Head" and "Beach," but what remains makes it evident that the islands were isolated at the time of, and are little altered since the date of their submergence.

Elsewhere in the areas submerged the "Head" has not been made, as in England, the object of special research, and may easily have escaped notice or have been placed in a different category. Still it is occasionally to be recognised in other districts from descriptive details. There are traces of both on the coasts of Spain and Portugal. At Gibraltar we find what may represent a large development of "Head" in the rubble there referred to, but with only a slight exhibition of an underlying Raised Beach. On the south coast of France a raised Beach was long since recorded at Nice, and one likewise exists at Mentone, where there is also a thick deposit of osseous rubble (p. 36). Both are again met with at a few places on the west coast of Italy (p. 49).

The descriptions we have of Sardinia in respect to these two deposits are not very clear, but they leave little doubt of their existence, together with deposits referable to other forms of the Rubble-drift.

In Sicily a Raised Beach is represented in the neighbourhood of Palermo by a shell-bed at the bottom of the Cave of San Ciro, but the overlying beds have been so disturbed and broken up that the exact relations of these to one another cannot now be made out. In front of this Cave, and probably going some way in it, a "Head" is represented by that extraordinary mass of ossiferous breccia which in places skirts some of the hills (p. 50). At Malta the Raised Beach has not been noticed, though there is no doubt that the Island was, like the Channel Islands, isolated at the time of the submergence which has left a well-defined ossiferous breccia on its south coast (p. 53).

Greece is largely covered by a thick mass of breccia, the equivalent both of the Rubble-on-slopes and of the "Head," and, though a Raised Beach is only recorded under it at one place, the lines of Pholas-borings in the cliffs afford equivalent evidence of a change of level, while in the Island of Cerigo there are well-marked ossiferous fissures (p. 56). In Crete the Drift beds present very similar features, with the addition of a well-characterised Raised Beach (p. 56).

On the opposite coast of North Africa, the phenomena are identical with those we have traced on the north side of the Western Mediterranean. Raised Beaches are extremely well marked, but the only place where from general description I would recognise a "Head" is at Arzen, near Oran. There is no mention of this form of Drift eastward of Tripoli or in Egypt (p. 62).

The coasts of Asia Minor furnish us with scant evidence relating to the Submergence. Raised Beaches have been noticed in several places, but no good case of a "Head" has been recorded; but then it may not have been sought for. Mention is, however, made of extensive detrital deposits of local origin, and of late Quaternary age, on the slopes of the hills. These may represent the Rubble-drift, and if followed down to the coast would probably be found to assume the character of a "Head." How far these deposits may extend eastward we have as yet no means of knowing. Observations are needed in Armenia, Kurdistan, and Northern Persia—countries which lie in the line of strike of the submerged area.[1]

The afore-named deposits belong to the coarser forms of the Rubble-drift swept off the surface during the emergence of the land. But there is another form of it which could not have failed to result as a consequence of the submergence; for as the waters encroached on the land, howsoever slow might have been their advance, the ablution of the surface soil and subsoils must have rendered them more or less turbid in proportion to the character of the strata. Where the rocks were hard, as in the south-west of England, and much of the Mediterranean area, the quantity of sediment would be small, but where, as in the south-east of England, in France, and Central Europe, there were

[1] May not the Caspian, the Sea of Ural, and other of these inland salt lakes and swamps be remains of this great submergence?

many soft and friable or decomposod rocks, and valleys surcharged with beds of fluviatile *Loess* deposited on their flanks during the Glacial period, then the waters must have become heavily laden with a mass of fine sediment. So long as the waters were kept in motion, little of this sediment would fall, but during intervals of rest, and at the high tide of the submergence, it would, especially in salt water, fall rapidly, and soon acquire large dimensions, and so cover the country as with a mantle. As the land rose from beneath the waters, divergent currents scoured the narrower passes and contracted channels, and carried down much of the subsided ooze and redeposited it at lower levels; whilst where the currents were slighter, or the sediment had fallen in sheltered positions or on tablelands, the deposit would suffer but little denudation. As with the other forms of the Rubble-drift, this sediment contains the remains of land animals and land shells, but in smaller proportion than the river sediments. It is a deposit which covers large tracts of Central Europe, forming a high-level Loess, and passing, when it is more argillaceous, into the common brick earths. In the Mediterranean area this diluvial Loess is probably represented in part by a very widely spread red soil or earth.

Having now sketched the geographical distribution of the Rubble-drift, in its various forms, I would direct attention to a few of the more typical exhibitions of it in several areas affected by this temporary submergence of the land, and their interpretation.

§ 2. Early Speculations of Geologists.

Very divergent have been the opinions which within the last century have been held respecting the later geological changes that have taken place on the surface of the Globe, whether in relation to their cause, or to the time of their occurrence, and of the introduction of Man. The presence of marine shells at great heights and far from the sea led early observers to attribute them to 'the Universal Deluge'—then the accepted belief. With the progress of Geology, it was, however, soon seen that these shell-beds belonged to different periods, and must be referred to other causes than those of a transient—much less a universal deluge, for the condition and character of the shells, and the fact of their growth on, and long occupation of, the spot, were seen not to agree with a short resting of the waters on the surface of the land; while a universal deluge was shown to be a physical impossibility. Failing to find support in the palæontological conditions, attention was directed with more apparent success to the physical conditions. It was found that the land was very commonly covered, sometimes by a superficial sprinkling, at others by a deposit many feet thick, of detrital materials, derived from the waste and wear of the rocks which cropped out on the surface; and this mass of materials, taken as a whole, was attributed to the rush of the waters of a transient flood.

Cuvier, in the *Essai Préliminaire* appended to his great work,[1] and afterwards (1826) published separately under the title of *Discours sur les Révolutions de la Surface du Globe*, after remarking on the earlier great geological changes marked by breaks in the continuity of life, which he considered had been sudden and catastrophic, goes on to speak of the last as one which "flooded and afterwards left dry our actual continents, or at least a large portion of those at present existing. It besides left in northern latitudes (Siberia) the carcasses of large quadrupeds embedded in ice, and thus preserved them to the present day with their skin, their hair, and their flesh. If they had not been frozen as soon as they were killed, putrefaction would have caused their decomposition. . . . The event was (in his opinion) sudden, instantaneous, and without any gradation."

At the time Cuvier wrote, the belief in the immutability of species was almost general, and it was therefore a logical conclusion with those who held that opinion, to suppose, as each break in the geological record was attended by the disappearance of old and the appearance of new forms, that the former were destroyed and that the latter were new and successive creations. The doctrine of *Evolution* removed the difficulty on the score of continuity, while the doctrine of *Uniformity* was held to be fatal to the belief in catastrophes. It was also the belief of Cuvier and his contemporaries that no human remains ever occurred in a fossil state, and they therefore held the

[1] *Les Ossements Fossiles*, 1812—1822.

appearance of *Man* on the earth to be of recent date, and subsequent to the disappearance of all the great extinct Mammalia, such as the *Mammoth*, *Woolly Rhinoceros*, and others. Human remains were supposed to be confined to Alluvial deposits, peat-beds, and similar beds now in course of formation.

Dr. Buckland, the Oxford Professor of Geology, shared in these opinions, and in his classic work[1] he asserted that human remains had never been discovered with those of the extinct Mammalia, and that they were only to be found in beds of low antiquity. He concluded that "the human race had not established themselves in those countries where the animals under consideration have hitherto been found, in the period preceding the grand inundation by which they (the animals) were destroyed." These observations are the more singular, because he himself gives several instances in which human remains had been found in caves and fissures in association with the Quaternary Mammalia. In one instance he mentions them as having been found in a fissure at a depth of twenty-six feet from the surface, and eight feet under bones of Rhinoceros. He considered, however, that this association arose from the circumstance that the animal remains had been washed down from higher levels and become mixed with the human remains during the Alluvial period. The association in caves was in the same way supposed to be due to some later disturbance. His conviction and that of his contemporaries on this subject

[1] *Reliquiæ Diluvianæ*, 2nd Edition, 1824.

was too strong to be shaken by any evidence then brought forward; and, though he afterwards abandoned his views respecting a universal deluge, he adhered to those respecting the recent appearance of Man. Nevertheless, Buckland's work is remarkable for wide research and careful collocation of facts, and can still be consulted with advantage. As Cuvier noted the sites and established all the more important characters of the Ossiferous Fissures, and of their Quaternary fauna, so Buckland described most of the essential features and sites of the Bone-Caves, and in both instances their works have formed the groundwork of all subsequent research on these subjects. It must also be remembered that at the time these distinguished men wrote the Drift had not been subdivided into its component stages, which were all taken together as one deposit, and as the result of one action—namely, the rush of the diluvial waters on the land. Whence they where all designated "*diluvium*," or "diluvial beds," terms which soon became obsolete in this country, but are still in common use on the Continent, although they are there now applied to Drift beds of very different origin and date, and have therefore no longer the significance of the original name. In consequence of these changes, the term, together with the diluvial hypothesis, fell into discredit, and were dropped, even by their authors, as untenable both on physical and biological grounds. Nevertheless, there is, I am satisfied, an element of truth in the original interpretation of the Drift phenomena, founded as it was on the experience of

many able observers, that has been lost sight of in the entire rejection of the hypothesis, which, in another form, it will be my endeavour to substantiate in some parts.

Thus, Buckland showed that immense deposits of gravel occur "occasionally on the summits and slopes of hills and almost universally in valleys . . . in situations to which no torrents nor rivers that are now in action could ever have drifted them," and he remarks on the fact that this gravel "is in part composed of the wreck of the neighbouring hills, and partly of fragments and blocks that have been transported from very distant regions." Though these observations may apply mainly to beds of glacial age, there is evidently an element in them which cannot be so explained. Instead, however, of eliminating what was superfluous, or referring it to its true place in the series, the whole interpretation of the facts by the early geologists was rejected, and explanations more in accordance with the belief in uniformity of action, which soon afterwards obtained ascendence, were put forward. Captivating as uniformitarian views are from their simplicity and easy grasp, they have in this case led to the introduction of a multiplicity of explanations, discordant with one another, and no single one of which admits of a sufficiently wide generalisation. Though the doctrine did good service in checking the extreme catastrophic opinions previously held, the too great reliance on it has had the disadvantage of staying inquiry, except within the circle of certain assumed standards.

§ 3. Drifts of Different Ages and Origins.

It was soon discovered that the superficial beds of Drift, instead of being the result of one Cause and belonging to one time, were the result of many agencies acting at different times and under different conditions. Thus the beds of gravel, loam, and sand lodged, especially in the north of France and the south of England, on the slopes of many of the river valleys, are now known to have been deposited by the same rivers in their earlier stages, when, before they had excavated their channels to the present depths, they flowed at various higher levels. That this was their origin is shown by the fact that these deposits contain fluviatile shells, mostly such as now live in our present rivers, together with the rolled and worn bones of land animals of species now extinct. The preservation of such remains is, however, partial and irregular, partly because the beds in which they are entombed are in general so permeable that the percolation of the surface waters has very commonly removed the chalky or calcareous matter of the bed itself together with that of the embedded shells and bones; but where these have been protected by beds of loam or clay, the organic remains are often well preserved. The higher and older the terrace, the more rare are the organic remains. There are good examples of the old river beds at Grays, Erith, Crayford, Oxford, etc.[1]

[1] The sections vary from year to year.

Another large section of Drift deposits contains rock *débris* and boulders, transported far from their native place, and, as it were, across country. This was formerly looked upon as evidence of the inrush of the diluvial waters, but now it is well established that these materials have been carried to their present positions by the slow action of either land or floating ice, and not by any sudden transport by water. On the hills north of the Thames, fragments from the Limestones and Coal Measures of Yorkshire are not uncommon, while in the Eastern Counties are found blocks and boulders ice-transported from Scotland and even Scandinavia. In this section of the Drift marine shells are occasionally met with.

Other portions of the superficial detritus may be attributed to the breaking up of the surface of the rocks by weathering and by the extreme cold of the Glacial period.

In this way the origin of the larger proportion of the superficial deposits of loam, gravel, and sand has been accounted for, and shown to be due to the same agencies, though often acting with greater energy and force, as those which now act upon the surface of the land, and that, so far from being the result of a sudden and transient catastrophe, they result from the long-continued and gradual action of known agencies, and represent the work of a long period of time.

I need not, however, dwell upon these recognised Drift deposits, which will be found described in the various text-books of Geology, and in papers published

in the proceedings of the Geological Societies of England and the Continent.

Notwithstanding that the bulk of the superficial drifts covering the country can be thus accounted for, there is nevertheless a residue which cannot, in my opinion, be referred to any of the causes assigned for the formation of these deposits. Such likewise was the conclusion which Sir Roderick Murchison[1] was led to form, though he failed to eliminate some of the established Drifts, and ascribed them all generally to a wave of translation. Professor James Geikie has also noticed one form of this Drift, but adopts in explanation of its origin a suggestion of Darwin's—that it is to be attributed to the cold and snow of the Glacial period. Though we thus differ in our interpretation of its origin, the essential fact remains of the recognition of an aberrant form of drift.

I have named this residue the "Rubble-Drift," as it is unstratified and complex and without the order and unity which distinguishes the fluviatile and marine drifts. The *débris* is as a rule *angular* and sharp, nor is any portion of it *glaciated or transported from beyond the immediate vicinity of the place* of their occurrence, as is the case with beds of glacial origin.

§ 4. The Rubble-Drift: its Various Phases.

This Drift not only varies according to the nature of the ground, but also in accordance with the inci-

[1] *Quart. Journ. Geol. Soc.*, vol. vii. p. 349.

[2] *Prehistoric Europe*, p. 140.

dents of its deposition. At one time it appears as a superficial mass of unstratified rubble or breccia in hollows or on slopes, at another as a breccia in fissures, and, thirdly, as a fine light-coloured loam or *loess*. But in all cases the organic remains for each district are of the same order and in the same condition.

The Surface Rubble and Head.—In the south of England this Drift commonly assumes the form of a bed, varying in thickness from a few inches to a few feet, of angular fragments of rock with loam, derived from adjacent higher ground, and lying on the slopes of the hills and at the bottom of the valleys. It is frequently altogether absent, but where there have been hollows in the original surface of the underlying solid rocks this Drift has lodged there in greater quantities, and occasionally attains a thickness of 20 to 80 ft. or more.

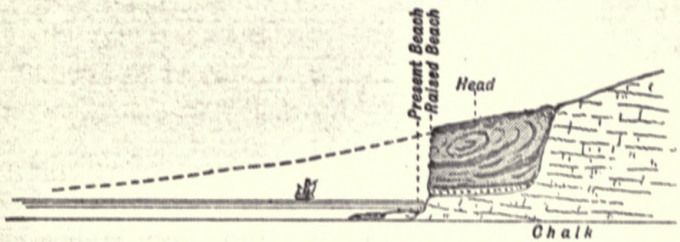
Previous to the deposition of this rubble the land in this area stood several feet *lower* than at present, and had been worn back by the sea so as to form a line of old beach and cliffs (see Fig. 1, p. 22), which, now that the land has been raised, stand 10 to 30 ft. above the existing sea level, and in places extend inland.[1] In the trough formed by the ledge of the Raised Beach and the face of the old cliff,[2] the rubble has often lodged in such large quantity as to completely mask the old cliff, which would not be

[1] *Quart. Journ. Geol. Soc.* for 1892, map plate viii., and *Geology—Chemical, Physical, and Stratigraphical*, vol. ii. pp. 513, 514.

[2] On the Raised Beaches of the south of England, *Quart. Journ. Geol. Soc.* for 1892, pp. 264–343.

visible were it not for the encroachment of the sea and occasional cutting back of the present cliff-lines. This is shown in Fig. 1, as is also the original extent of the Rubble-drift seaward, and the present position of the Raised Beach and *Head* on the coasts of the Channel. The dark seams in this section represent the irregular masses of coarse rubble, and the lighter parts the finer *débris*, but this only holds good when the strata consists of beds of different degrees of hardness, as in the Chalk and Oolitic districts.

FIG. 1. Section of the Raised Beach and *Head* in a Chalk district.



The Raised Beach is the dotted seam under the "Head."

Where the rocks consist of uniformly hard strata, as in Devon and Cornwall, the whole detrital mass exhibits sharp angular fragments of rock, and the divisional lines of rough bedding are scarcely apparent.

This overlying mass of rubble has been termed *Head*, a name by which we will continue to designate it, though it does not actually differ from the rubble on the slopes of the inland hills where there are no cliffs for it to lodge under. Sections of the head are exposed in the cliff at Dover,[1] at the east

[1] Behind the South Eastern Railway Station.

end of Brighton, at Portland Bill, and at various places on the coast of Devon and Cornwall. It is everywhere composed of angular and unworn fragments of the adjacent local rocks—thus at Dover and at Brighton it consists of broken chalk and flints, at Portland of Oolitic *débris*, and at Baggy Point, near Barnstaple, of sharp fragments of slaty rocks. It contains generally very few organic remains, and those are confined to the bones of *land animals* and to *land shells*. The former embrace the following species:—

*	Elephas primigenius	*Mammoth.*
*	„ antiquus	
*	Rhinoceros tichorhinus... ...	*Woolly Rhinoceros.*
*	„ megarhinus... ...	
	Equus caballus	*Horse.*
†	Bison priscus	*Bison.*
	Bos longifrons	*Short-horned Ox.*
	Cervus elaphus	*Red Deer.*
*	„ megaceros	*Gigantic Irish Deer.*
†	„ tarandus	*Reindeer.*
	Sus scrofa	*Wild Boar.*
*?	Hippopotamus major	*Hippopotamus.*
	Canis lupus	*Wolf.*
‡	Hyæna crocuta	*Spotted Hyæna.*
	Ursus	*Bear.*

* *Extinct species.*
† *Living in England within recent times.*
‡ *A living African species.*

The shells are all of recent species, and most of them still living in this Country.[1] Snail shells (*Helices*) largely predominate. A marsh shell (*Suc-*

[1] They have also a very wide Continental range.

cinea) is also common, while the little Chrysalis shell (*Pupa marginata*) which lives under stones and among dead leaves is often abundant and is very characteristic. The following are the species that have been found in the *Head* on the south Coast.

Helix concinna	Cyclostoma.
„ nemoralis	Limnea peregra.
„ pulchella	„ truncatula.
„ virgata	Planorbis glaber.
Zua lubrica	Pupa marginata.
Succinea putris	Limax agrestis.
„ oblonga	
Bythinia tentaculata	

It is only when the conditions have been favourable, as at Folkestone and Portland, where there are seams of soft loam and fine chalk rubble, that these delicate shells have been preserved. In the rough and stony rubble of Devon and Cornwall they have not yet been found.

In the same way the Mammalian remains are only found where there has been a matrix favourable for their preservation. In the thick mass of chalky rubble which underlies East Brighton they were so common that Dr. Mantell designated the deposit the *Elephant Bed.* When the *Head* consists of slaty fragments in a sandy matrix, no bones are found, owing probably to the free circulation of the surface waters. That they were, however, imbedded occasionally is proved by the fact that I found a tooth of a Fossil Horse in the *Head* at Hope's Nose, near Torquay. In the papers before quoted several instances will be found of the occurrence of Mammalian remains

in this Drift in other situations, but the above are enough for the general argument.

Human remains are exceedingly rare, but stone implements fashioned by Palæolithic Man have been discovered in several places. One of the best instances is the flint implement of the lance-head Amiens type found at Portslade, near Brighton, at a depth of 15 feet from the surface in a bed the equivalent of the Brighton Elephant Bed. It is now in the Brighton Museum.

The Ossiferous Fissures.—Another form under which the Rubble-drift occurs is that of a breccia in rock-fissures. This breccia occasionally contains Mammalian remains, whence the term of "Ossiferous Fissures." These fissures or rents have been filled up to the level of the ground with angular fragments of the adjacent rocks embedded in a red earth or clay, often cemented by calcite. In England they are common only in the limestone rocks of the neighbourhood of Plymouth. The fissures are of variable width, are sometimes vertical, and at other times inclined at various angles, and the sides are rough and irregular. The rock fragments, which are angular and sharp, are of all sizes. The bones are rarely perfect, and are often broken into innumerable fragments. No skeleton is found entire.[1] The separate bones, in fact, have been dispersed in the most irregular manner, and without any bearing to their relative position in the skeleton.

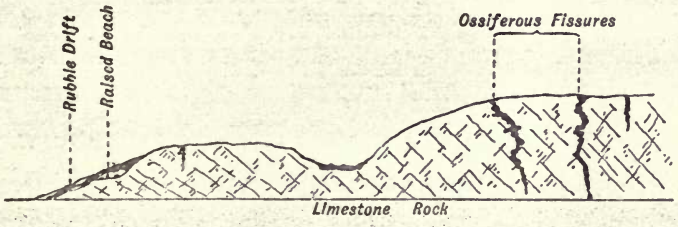
[1] Judging however from the occasional position of the bones, it would seem that entire limbs with the ligament attached were sometimes washed in.

Neither do they show *wear, nor have they been gnawed by beasts of prey,* though they occur with the bones of *Hyæna, Wolf, Bear,* and *Lion.* The relative proportion in which these remains occur in the fissures is shown in the following table, compiled by an early visitor to the quarries at Oreston, near Plymouth.

Species.	Teeth.	Jaws.	Vertebræ and portions of skulls and bones more or less perfect.	Fragments of bones without distinct characters.
Cave Tiger... ... Cave Hyæna ... Wild Boar... ... Fossil Horse ... Ox ... ... Deer ... ... Wolf ... ... Fox ... ... Hare ... ... Water Rat	1,587	147	279	1,000

Bones of the *Mammoth, Rhinoceros, Hippopotamus, Reindeer, Bear,* and *Bison* also have been met with. Human remains have been reported, but this wants confirmation. The relation of the Rubble-drift (*Head*) to the Ossiferous Fissures on the coast of Devonshire is given in the following diagram section.

FIG. 2. Ossiferous Fissures near Plymouth.



The Loess.—This deposit is so slightly developed in England that it will be better to postpone its

consideration until after the description of it on the Continent of Europe, where it covers extensive tracts. In the meantime we can consider the theoretical questions suggested by the phenomena already noticed, especially with respect to the *Head* which is better developed in England than on the Continent.

§ 5. The Origin of the Angular Rubble and "Head."

Various explanations have been suggested,[1] but though they might account for some features of the *Head*, no one suffices to account for its several varied forms of the Rubble-drift, and they all especially fail to meet the consequences which would follow on their assumption. We must look therefore for some other explanation, and the one to which I have been led, taking into consideration the collateral phenomena, is that of a temporary submergence of the land and its subsequent re-elevation.

The late Mr. Hopkins[2] of Cambridge has shown that if a considerable area at the bottom of the sea were *suddenly* elevated, a wave, accompanied by a current, the velocity of which would depend principally upon the depth of the sea, would diverge in all directions from the centre of disturbance. Calculations, he says, "prove beyond all doubt that paroxysmal elevations, beneath the sea, varying from 50 to 100 feet in height, may produce currents of

[1] For these see Appendix C.

[2] *Quart. Journ. Geol. Soc.*, vol. iv. p. 90.

which the velocities shall vary from at least 5 or 6 to 15 or 20 miles an hour, provided the depth of the sea do not exceed 800 or 1,000 feet." In considering the magnitude of the blocks which might be moved, he found that the force exerted on a surface of given magnitude *increases as the square of the velocity*, and that it varies *as the sixth power of the velocity of the current.* But the movements must be repeated for large blocks to travel beyond short distances.

It is evident that we have in this form of disturbance an engine of vast power, and, though our hypothesis does not deal with the greater and more rapid movements and powerful currents contemplated by Mr. Hopkins, we may infer what the results might be with changes having even only a fraction of such magnitude. Movements of this character would, like Nasmyth's hammer, be capable at times, when the uplift though short was rapid, of exerting enormous force; while at other times, when the uplift was slow, the action might be of the most gentle description. It follows from these premises that the character of the deposits formed under such circumstances will afford an approximately relative measure of the velocity and duration of the currents under which they were accumulated. Where, for example, the sediment is fine and thin, we may conclude that the velocity was slow, and the rise which gave origin to it small. When, on the contrary, the materials are coarse, we may suppose the rise to have been more rapid and the velocity of the current greater, though the movement might have been continuous.

The bones are dispersed irregularly throughout the mass of rubble, but the land shells are confined to the finer beds. Fragments of wood are only occasionally met with. Decay, however, has generally destroyed all the vegetable matter.

These considerations, added to the circumstance that this rubble contains the remains of *a land fauna only*, led me to infer that the South of England had been submerged at the close of the Post-glacial period to the depth of not less than about 1,000 feet, for to that height there are traces of this Rubble-drift. As the surface of the submerged area shows no marine terraces indicating periods of rest, it may be inferred that the submergence was comparatively slow and gradual, the only disturbance being the removal of the finer surface materials and sediment, with which the waters would become charged. On the other hand, the alternation of fine and coarse materials in the *Head* indicate that the upheaval was by movements alternately slow and rapid, during the latter of which the *débris* of the surface so submerged was swept down to lower levels, or lodged in the hollows and fissures of that surface, together with the remains of the animals and land shells that had inhabited the submerged land. I conclude, further, from the absence of marine sedimentation and of marine shells on the submerged area, that the submergence was of too short duration to admit of such sedimentation, or to afford time for the immigration of a marine fauna from adjacent unsubmerged areas.

§ 6. The Origin of the Ossiferous Fissures.

After describing the several ways by which the animal remains might have been introduced into the fissures, Buckland concluded that during the Quaternary period there were open rents in the limestone rocks, into which the animals fell, and that their bodies remained undisturbed on the spot on which they died until drifted forward and dispersed by inrushes of water. Admitting the possibility that the fissures might prove pitfalls, all the bones of the skeleton ought, as the animals are supposed to have fallen alive into the fissures, to be there, howsoever dispersed the separate bones might be: but that is never the case. The bones are dispersed without order or proportion. Surely also some of the skeletons would have been preserved entire. Again, if left for a time exposed in the fissures, the bones would be variously weathered, which they are not. Nor would the mere fall have been sufficient to have caused the extensive breakage of the bones have undergone: these, I consider, are fatal objections to this explanation, and none other has since been offered.

Besides this the *débris* forming the osseous breccia is, like that forming the *Head*, perfectly angular, the animal remains are of the same species, and the bones are broken, unworn, and dispersed in the same way. Both have, I apprehend, had the same origin, only that in the one case the rubble has been shot over mural precipices, and in the other into open fissures, and

in both with violence sufficient to break and smash the bones.[1] Sir H. de la Beche, speaking of the osseous breccia at Oreston, remarked that some of the matrix was "apparently impregnated with animal matter"—an observation which has been made in other instances. It has also been noticed that from the position in which some of the bones occasionally lie, detached limbs may sometimes have been still united by their ligaments when washed in. These facts would indicate that the entombment was effected quickly, and not long after the animal's death.

The evidence therefore in the English area tends to prove the identity of the *Head* with the breccia in the fissures. We will now turn to the Continent, and see how far this evidence is confirmed by the phenomena to be observed there.

§ 7. Proofs of Submergence on the Continent.

Phenomena of the same class as in England exist in various other parts of Western Europe and along the coasts of the Mediterranean, though they present, in addition, features which, while differing in detail, bear the same construction and point to the same common origin, being all explicable on the hypothesis of a comparatively recent, geologically speaking, submergence of the land.

France and Belgium.—On the eastern slope of Cape Blanc Nez is a mass of chalk rubble overlying

[1] Where the rubble has only been carried down gentle slopes, as at Upton, near Didcot, the bones are more entire.

a Raised Beach 10 feet above the present beach. At one end of the section this *Head* rises to the height of nearly 100 feet, and at the other it inclines downwards to within a few feet above the sea level at the village of Sangatte, four miles west of Calais. This fine section, which extends nearly half a mile[1] along the coast, is almost a counterpart of that at Brighton, but, whereas at the latter place the greater part of it is hidden by a sea-wall, at Sangatte it is exposed for its whole length except where temporarily hidden by falls of the cliff. The distance to which the last upper bed of flint *débris* has here been propelled into the plain is a noticeable feature.

The lower jaw of a Mammoth has been found in this Drift, but Mammalian remains are on the whole much scarcer than at Brighton. On the other hand, land shells, which have not yet been found at Brighton, occur in places in considerable numbers, though the species are few. They include—

Helix concinna	...	...	Pupa marginata.
„ pulchella	...	...	Arion ater.
Succinea oblonga	...	...	Limax agrestis.

The occurrence of land-slugs is not a common feature. A few worn specimens of Palæolithic flint implements have also been found.

In the estuary of the Somme the sections are important, inasmuch as the Raised Beach at Menchecourt, near Abbeville, is overlaid by an ordinary fluviatile deposit of Pleistocene date, to which succeeds

[1] Its apparent length is increased by its not being at right angles to the old coast line.

a Rubble-drift or *Head*, so that the age of the latter is thus clearly shown to be later than the latest of the Quaternary fluviatile deposits, and to precede immediately the Alluvial deposits under which it passes in the valley.[1]

It is not necessary to follow these deposits further on the coast of France. Suffice to say that they exist in places on the coasts of Normandy and Brittany, and may be traced at intervals to the frontiers of Spain. Their instructive exhibition in Guernsey and Jersey will be considered in another chapter (*postea*, p. 44).

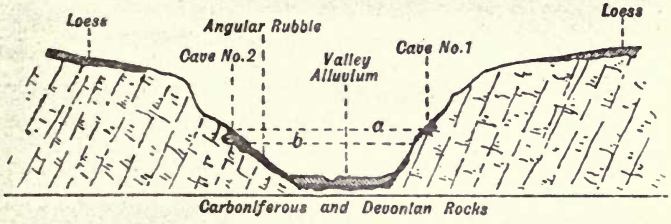
In the interior of France and in Belgium, we find, as in England, this Drift in the form of a superficial angular rubble, and of a breccia in fissures. Its position with respect to the celebrated bone-caves of Belgium, is particularly interesting, as it defines its precise geological age with reference to such caves and shows its relation to the Palæolithic as well as to Neolithic periods. These caves, of which there are several in the valleys near Dinant,[2] are situated on the steep banks of the rivers, which come down from the Ardennes and flow into the Meuse, cutting deep narrow valleys through the limestones and associated rocks of those hills. The caves are situated at various heights above the streams, and were formed at different stages of the valley erosion. The Cave deposits contain the bones of the various Pleistocene

[1] See Appendix D for further particulars.

[2] They are described by M. Dupont in his *L'Homme pendant les Ages de la Pierre dans les Environs de Dinant-sur-Meuse.*

animals, those of the *Mammoth* preponderating in the lower, and those of the Reindeer being more abundant in the upper beds, where they are associated with a larger number of the worked flints of Palæolithic Man. Overlying all these beds was a mass of *débris* from the rocks above, which masked the Cave deposits in the same way that the *Head* masks the old cliffs of the Channel. Resting on the top of this rubble, there is occasionally a layer of *débris* containing the stone implements of Neolithic Man, together with the remains of *Horse, Ox, Reindeer*, and other recent species, as also of several recent species of birds. The position of these caves is indicated generally in the diagram, Fig. 3.

FIG. 3. Diagram-Section across a Valley in the Ardennes, showing the relative position of the Caves (or Rock-Shelters), of the angular Rubble-drift, and of the Loess.



(*a*) Level of the river at the time of the erosion of rock-shelter or Cave No. 1.

(*b*) Level at the subsequent period, when Cave No. 2 was formed.

The tale that these caves tell is this: At the date of No. 1 Cave the river had excavated the valley to the depth of the line *a*. The work of erosion continuing, another cave was formed on the level of *b*, to which we will confine our attention. On the ledge worn out on the level of *b*, the old river deposited a layer of rounded pebbles, carried down by the stream

from the more distant parts of the Ardennes. As the river gradually wore the valley-channel to a greater depth, this gravelly floor was left dry, and the cave became frequented by predaceous animals who brought there their daily prey. But though the level of the river was lowered, the cave remained for a time within reach of the spring floods caused by the melting of the snow on the Ardennes, while the sediment from these muddy waters covered and imbedded the animal remains. With each succeeding year the cave became, as the valley was worn deeper, more out of reach of the flood waters, until finally it was left so dry as to be frequented by Palæolithic Man, who brought there the animals on which he fed. Whence the abundance of deer and other ruminant bones, scattered with flint flakes and other implements in the upper part of the Cave deposits.[1]

After this the whole land was submerged, and covered in places by a mantle of fine silt or Loess. As it emerged, the effluent waters swept down the loose *débris* from the ground above, together with the remains of animals drowned, and deposited this rubble on the slopes below, closing or nearly closing the mouth of the caves and covering up the Cave beds. That the derivation of the *débris* was local and not from a distance, is proved by its being altogether of local origin and not river-worn, as also by the circumstance that it contains, at a lower level than the mouth of the cave, fragments from the Cave beds above, while

[1] For lists of these Palæolithic and Neolithic animals, see Appendix E.

the transient nature of the event is indicated by the fact that these soft clay and sand fragments are entire and not broken up and lost in the detrital mass.

The surface of this Rubble-drift left dry on the retreat of the waters continued to afford, where protected by overhanging rocks, shelters which were frequented by later or Neolithic Man, who has there left traces of his habitation in his stone implements mixed with the refuse of the products of his chase.

Osseous Breccias.—Several of these accumulations have been described in the valleys around Paris. One very striking example occurs more inland near Semur, where a hill (Mont Genay) 1,430 feet high has apparently been entirely submerged, and a bank of breccia, derived from the rocks which cap its summit, and containing the remains of the *Mammoth*, *Reindeer*, *Horse*, &c., with *land shells*, has been formed on its flanks. Another large mass of ossiferous breccia was met with near Mentone in a cutting of the railway, where it passes under limestone cliffs, which there rise to the height of 260 feet, and in which is situated the celebrated cave of Baussi Roussi. Below the cave and forming a steep slope extending down to the shore, was a thick mass of angular *débris* derived from the hills above, and so hard that it had to be blasted with gunpowder. In this breccia at depths of 30 feet or more, teeth of *Cave Bear* and *Spotted Hyæna*,[1] together with flints worked by Man, were found.

[1] Moggridge, *Brit. Assoc. Reports for* 1871, p. 156.

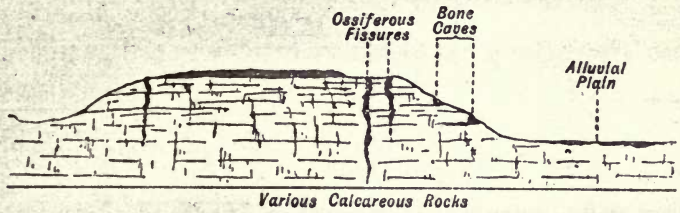
Ossiferous Fissures.—Other proofs of submergence are not wanting. Of these we can only mention a few of the more striking, amongst which are the Ossiferous Fissures, common not only on the Mediterranean coast but even on high hills in Central France. The breccia which fills them contains the remains of *Mammoth, Woolly Rhinoceros,* and other Quaternary animals; and what is important to notice is the fact that these fissures are situated on *isolated hills* which are often of considerable height. To account for the presence of the animal remains, it has been suggested, as in the case of the Plymouth fissures, that the bones are those of animals which fell into open rents, or else that they were remains brought together by predaceous animals. Neither of these explanations can be accepted, for *no skeleton is found entire,* very few of the *bones are in their relative position,* and none of the bones *have been gnawed* by Carnivora. As M. Gaudry observed, when discussing the facts presented by the fissure on the "Montagne de Santenay"—a flat-topped hill near Chalons-sur-Saône,—"Why should so many Wolves, Bears, Horses, and Oxen, have ascended a hill isolated on all sides?" Some members of the Geological Society of France present at the *réunion* at which this remark was made, seemed to think that the animals had met their death by drowning, but in what way was left indeterminate.[1]

In most, if not all, of these cases, these hills rise *in the midst of plains or low grounds.* At Nice the

[1] *Bull. Soc. Géol. de France,* 3rd series, vol. iv., p. 681.

hills are 132 and 436 feet high, at Antibes, 250 feet, and at Cette the hill, which resembles on a small scale the Rock of Gibraltar, rises 355 feet above the sea level. Still more formidable are the hills inland. Mont Pédémar (Gard) rises to a height of 1,128 feet, whilst Santenay is not less than 1,640 feet high. The relation of these hills to the surrounding plains, and of the Fissure to certain bone caves is shown in Fig. No. 4.

FIG. 4. Diagram Section showing the position of some of the Ossiferous Fissures on high isolated hills.



Amongst the animal remains found in the several Ossiferous Fissures are those of:—

5 Carnivores	Cave Lion.	4 Ungulates	Mammoth.
	Lynx.		Rhinoceros.
	Wolf.		Wild Boar.
	Spotted Hyæna.		Horse.
	Bear.		
2 Rodents	Lagomys.	3 Ruminants	Ox.
	Hare.		Deer.
			Antelopes.

Together with *land shells* of various living species. The breccia, which is composed of *sharp angular* fragments of the local rocks, imbedded in a matrix of red clay or loam, is generally cemented by calcite. The bones are mostly broken and splintered into innumerable sharp fragments, and according to M.

Gaudry, the distinguished Professor at the Jardin des Plantes, the remains at Santenay are evidently *not those of animals devoured by beasts of prey; nor have they been broken by man.* Nevertheless, the remains of *Wolf* were particularly abundant, together with those of the *Cave Lion, Bear, Rhinoceros, Horse, Ox, and Deer.* It is not possible to suppose that animals of such different natures, and of such different habitats, could in life ever have herded together.

Besides, we have at Santenay a clue to the animals frequenting the district at the time of the submergence, for on the upper slopes of the hill there was, on one side, an ordinary bone-cave of Pleistocene age, the resort of *Wolves,* while on the other side was a *Bear's* den of the same age, with, in each case, the remains of the animals which had served as their prey. The remains of these Carnivores together with those of the Ruminants of the plain (*Horse, Deer, Bovidæ*), are now associated in the fissure on the summit of the hill, whither, we may suppose, all these animals had fled to escape the rising waters.

We will now consider what I conceive to be another result of the Submergence in Western Europe.

The high-level Loess of France and Central Europe. If the Osseous Breccias and Ossiferous Fissures are to be accepted as evidence of a wide-spread submergence, the turbid flood waters ought to have left other traces on the sunken area. And such is the case, for I take the high-level Loess of the Continent to be a deposit from flood waters; the nature of that

sedimentation necessarily depending upon the character of the lands over which the waters spread.

We must bear in mind the topographical conditions prevailing at the time. At the close of the glacial period when those changes took place, glaciers descended from all the great mountain ranges of Europe, and annual inundations, caused by the melting of the snow, brought down large quantities of mud and silt which was deposited on the flanks of the chief river valleys. It is this which constitutes the *fluviatile Loess* of the valleys of the Rhine, the Danube, the Seine, the Rhone, and other rivers. This however only forms local deposits and is confined to the valleys.

But there is another and larger deposit of Loess to which such an origin cannot be ascribed, for this latter is not confined to the river valleys, but is found on the dividing watersheds and on the high plains separating the river basins. In the north of France this high-level Loess is found at heights of 400 to 600 feet, and in the neighbourhood of Lyons of 1,300 feet, whilst in the great upper valleys of the Rhine and Danube it reaches to an altitude of 1,500 feet, and this is even exceeded further to the east, where likewise it covers the extensive high plains of Hungary and Southern Russia.[1]

As the ocean waters advanced over the submerged surface, large portions of the older fine and slightly coherent fluviatile Loess in the valleys would be taken up by them; while, as the level of the land was lowered, the ice and the snow on the mountain

[1] See Appendix F.

summits melted and added their glacial silt to these mud-laden waters.[1]

On the uplift of the land portions of this sediment would be swept away by the effluent waters, and deposited again on lower levels. Much would nevertheless be left at high levels, where the currents were comparatively slow, while, as the waters fell and became restricted to narrower channels, the velocity of the currents, and consequently their erosive power would increase. The denudation, therefore, in the valleys would be considerable whilst on the plateau lands it might be comparatively slight.

Large portions of the high-level Loess are unfossiliferous; when organic remains are present they are always those of a land surface. Land shells, and the remains of the ordinary Quaternary Mammalia, such as we have noted in the *Head*, and ossiferous fissures are of occasional occurrence. In some few instances human remains have been found.[2]

[1] Argillaceous silt of this description falls with extreme slowness in fresh water, whereas in salt water it is precipitated with great rapidity. It has been found (Robertson, *Trans. Geol. Soc.* Glasgow, vol. iv., p. 257) that in four hours a precipitate takes place in salt water, which it takes days to effect in fresh water. We can conceive, therefore, that after the submergence, the turbid flood waters would quickly settle and throw down a mantle of loam over the submerged land, especially in the vicinity of the glacier centres.

[2] Until the division between the high-level and the fluviatile Loess has been better defined, some uncertainty must exist as to which of the two forms of Loess, some of the organic remains hitherto found, are to be referred.

The entire absence of marine remains in this as in other forms of the Rubble-drift might seem a grave objection to the hypothesis of Submergence. But if the conclusion that I have drawn from the physical conditions be correct, the submergence was slow and not attended by any such inrush of water as would carry before it the marine exuviæ and pebbles of the shore, whilst the absence of marine sedimentation shows the submergence to have been a transient one. The turbidity of the waters would also be fatal to animal life, and a lengthened time would be necessary for the introduction of a new fauna from adjacent districts.

Since the reading of my paper at the Royal Society, some analyses made in the Agricultural Laboratory at Gembloux tend to corroborate the sea-flood origin of Loess, though further observations are needed before this connection can be fully established. It would appear that in certain districts of Belgium, the Loess is largely impregnated with salt.[1] In one instance the proportion of *chloride of sodium* was as much as 1·17 per cent.; in another 1·15 per cent., and in a third 0·407 per cent. At the same time, the presence of land shells such as *Helix hispida* and *Pupa marginata* shows the land origin of the sediment itself. In general the *Loess* is so permeable that the rain-water would remove any salt that there might have been left in it, but in some

[1] "Sur la Présence du Sel Marin dans quelques Types de Limon, par Xavier Stainier," *Bulletin de l'Agriculture de Belgique, Journal Officiel.* Volume for 1893.

instances the Loess is sufficiently argillaceous to prevent the free percolation of the surface waters, while at the same time it would favour the retention of the salt.[1]

The Raised Beaches of Guernsey and Jersey.—Before leaving the subject of the Loess, which would require a volume to deal with fully, I may mention another case which shows still more clearly the insufficiency of river or rain agencies to account for the presence of *Loess* in certain situations. Guernsey and Jersey consist of hard slate and granitic rocks rising to the height of 300 to 400 feet above the sea-level, and forming plateaux ending on most sides in high cliffs fronting the shore. These plateaux are often covered by a deposit of brick-earth or Loess, which attains in some places a thickness of ten to twenty feet or more, whilst the cliffs are fringed by remnants of a Raised-beach from eight to twenty feet above the level of the present beach. Originally this old beach must have been continuous all round the islands, which proves them to have been separated from the Continent long before the period of the Rubble-drift. Now only fragments of it remain at intervals, and these are everywhere covered by a *Head*, ten to thirty feet in thickness, consisting of angular *débris* derived from the adjacent rocks, and embedded in a matrix of the Loess from the plateau.

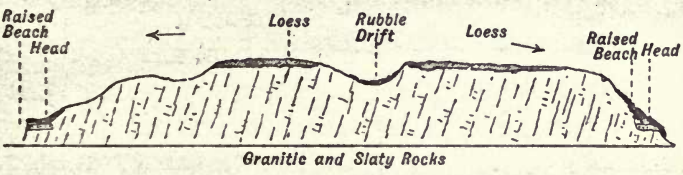
It is evident from this that the deposition of the *Loess* accompanied or preceded that of the *Head*. It is evident also that owing to the absence of

[1] See Appendix G.

rivers and the small size of the drainage areas, it is impossible to ascribe the Loess to river inundations; nor, in the absence of any ground higher than that of the plateaux, can it be ascribed to rain-wash. Neither, as the islands were clearly isolated at the time, can it be connected with any Continental glacial flood. On the other hand, the hypothesis of a Submergence perfectly meets all the conditions. A beach was first formed round the islands during the Quaternary period, and when the land stood eight to twenty feet lower than at present. The submergence then followed when the turbid waters deposited on the weathered land surface, the fine sediment constituting the *Loess*.

As the land rose again divergent currents shot down on all sides (Fig. 5), carrying before them the

FIG. 5.—Diagram-section across a Channel Island (Guernsey and Jersey).



The arrows show the direction of the effluent currents.

more exposed portions of the Loess together with fragments of the underlying and disintegrating rocks, and precipitating this mass of local rubble over the cliffs on to the old beach below. That the propelling force was at times considerable, is shown by the distance seaward to which this *angular* rubble at the islet of La Motte, on the south coast of Jersey, has been carried from the inland hills (*Phil. Trans.* for 1893, p. 917).

Though no Mammalian remains nor land shells have been discovered in the Channel Island Loess, land shells have been found in the Loess of the island of Bréhat, situated off the adjacent coast of Brittany, the structure of which is similar to that of the Channel Islands.

We have here, therefore, on a small scale, results precisely analogous to those exhibited on a larger scale on the Continent. I look upon this case as a crucial test in favour of the Submergence hypothesis. It fulfils all the conditions of the problem in a way no other interpretation of the phenomena admits of.[1]

Spain and Portugal: *Gibraltar.*—Here we find few traces of the Raised Beach or the *Head*, for the force of the Atlantic waves on the western coasts of the Peninsula has been such as to denude or altogether remove these littoral deposits. Nevertheless, there are sufficient, though slight, traces to show that both the beach and the *Head* were originally continued to the Straits of Gibraltar. There is reason to believe that all the lower ground and hills in the intermediate area between the Rock and the south of France was submerged in like manner.

The later physical history of the Rock of Gibraltar, has been investigated by Dr. Falconer,[2] Mr. G. Busk,[3]

[1] See my paper in *Phil. Trans.*, 1893, p. 915. Mr. A. Collenette's interesting observations, made independently, have led him also to conclude that Guernsey has been submerged at some recent time. He differs however from me in his account of the "Head." *Trans. Soc. Nat. Science* for 1892: *Guernsey*, 1893.

[2] *Palæontological Memoirs*, vol. ii., p. 556.

[3] *Trans. Zool. Soc.*, vol. x., p. 2.

James Smith,[1] Sir A. Ramsay, and Professor James Geikie.[2] Raised Beaches were traced by Mr. Smith up to the height of 600 feet, if not higher, showing that the Rock, which now rises 1,370 feet above the sea, was, in Quaternary times, an island not more than about 800 feet, or less high, which rose by successive stages to its present height. It is more than probable however, that at some time before it settled at that level, the whole of the area was upheaved to such an extent that a land passage was formed to the African coast, which allowed of and accounts for, the immigration of the *Spotted Hyæna*, the *Caffir Cat*, the *Ibex*, and the *African Panther* and *Elephant*, of all of which the remains have been found either on the Rock or in the Quaternary deposits of Spain. According to Mr. G. Busk "the entire fauna exhibits purely African affinities."

At a later period, the whole or the greater part of the Rock appears to me to have been submerged, and that as it rose again, currents swept off its surface the mass of angular *débris* spread out at its base and filling partly or wholly the numerous fissures which traverse the limestone rocks. On the eastern side the Rock presents an almost precipitous wall which afforded only a few ledges for the lodgment of *débris*, but on the western side, where the slope, though rapid at first, ends gradually, the *débris* forms in the lower

[1] *Quart. Journ. Geol. Soc.*, vol. ii., p. 41. My reasons for venturing to dissent from their interpretation are given in the *Trans. Roy. Soc.* for 1883, p. 946.

[2] *Quart. Journ. Geol. Soc.*, vol. xxxiv., p. 505.

grounds a Breccia in some places 100 feet thick, and extending to and under the sea. It is in every respect similar to the Rubble-drift or *Head* of our own shores. It is perfectly *angular;* it contains blocks of a large size (some are twelve feet in diameter); it is all derived from the adjacent rocks; and, like the breccia on the coast of Mentone, it is cemented by calcite and forms a hard unstratified rock. In a few places it overlies portions of a Raised Beach.

Like much of the Rubble-drift in England, this Breccia contains very few organic remains. Only a few rare fragments of Mammalian bones have been yet recorded, but the opportunities of search have also been few. The large size of several of the blocks and the distance to which the mass has been carried seaward, shows the action of a propelling force far greater, it seems to me, than could result from the agency of sliding snow to which it has been referred.

The numerous fissures that intersect the Rock have been filled with a similar breccia, which is sometimes fossiliferous. Owing to the size of some of the fissures and the inequalities of their walls, large cavities have often been left, which have since served as caves for the more recent wild animals and Neolithic Man. The remains of *Panther, Lynx, Caffir Cat, Hyæna, Wolf, Bear, Rhinoceros, Horse, Wild Boar, Red Deer, Fallow Deer, Ibex, Ox, Hare, Rabbit,* have been found in these Ossiferous Fissures. The bones are mostly broken into thousands of fragments—*none* are worn or rolled, nor are any of them *gnawed,* though so many Carnivores then lived on the Rock.

Dr. Falconer observed that in no case do the bones belong to one complete skeleton of any of the larger Mammalia. A human molar tooth and some flint flakes worked by Palæolithic Man were also discovered in the breccia of one of the fissures.

It has been suggested that these remains are those of animals that had lived and died on the Rock, and were afterwards washed into the fissures by heavy rains. But the condition of the bones renders this difficult to conceive, and besides there is the same incompatibility in the habits and resorts of the animals thus associated, as in the cases before mentioned. The *Hyæna*, *Felidæ*, and *Bears*, might have frequented the dens and crags of the Rock, but the *Deer*, *Bovidæ*, *Horse*, and others, must have lived in the surrounding plains, and it has not been suggested that they were carried to the Rock by carnivora, for the bones would then have been gnawed. A great and common danger, such as a great flood, alone could have driven together the animals of the plains and of the crags and caves. When the Rock again emerged, the *débris*, consisting of the limestone disintegrated during the previous long cold period formed with the scattered remains of the animals and men drowned by the inundating waters, this huge body of Rubble. The scale is different, and the materials are different, but in all essential respects the phenomena are analogous to those presented by the "*Head*" at Brighton and Sangatte. There is the same restriction to local *débris* with large blocks, the same absence of wear, the same traces of rude bedding, and the

same occasional presence of Mammalian remains. I infer, therefore, that the originating cause was the same in all these instances.

In contrast with these remains of Quaternary age, are those of the more recent fauna found in the cavities or caves in the older breccia, which have served as habitations for Neolithic Man, or as dens for wild animals of existing species. In these newer caves, the bones are as usual *worn and gnawed.*

Corsica, Sardinia, and the Balearic Islands.—Similar phenomena, but less definite in their character, have been noticed in all the islands, though the larger Mammalia are in general absent. There are the same old beaches, the same surface detritus, and the same Ossiferous fissures, all indicating the action of the same agencies, with slight modifications due to their insular position.

Italy and Dalmatia.—In Italy the Pleistocene beaches of the neighbourhood of Genoa and Leghorn, and the Ossiferous breccia, which is not distinguishable from that of Gibraltar, of the fissures in the vicinity of Pisa, have long been known. These breccias contain the remains of a few Carnivora and Ruminants together with land shells—*Helix* and *Cyclostoma.* More recently Professor Capellini has described a fissure near Spezzia in which he found the remains of the Hippopotamus, which is so abundant in the breccia in the neighbourhood of Palermo.

Istria and Dalmatia present similar features, but details are wanting. The Abbé Fortis, in the last century, spoke of the "extraordinary abundance of

bones" in the fissures of the limestone rocks on the coast of Dalmatia, but detailed particulars are still wanting.

Sicily.—This island presents phenomena still more remarkable, and which, as in the case of Gibraltar, have been investigated by several competent observers.[1] Though the osseous breccia is in close proximity to, and has been described as, a Cave deposit, the connection seems to be merely accidental, the breccia, like the *Argile à blocaux* of Belgium, only facing and partially obstructing the entrance (*ante*, p. 34). It does not really belong to the Cave deposits, but is, I imagine, the equivalent to our Rubble-drift.

The chief localities, which centre on the hills around Palermo, arrest attention from the extraordinary quantity of bones of *Hippopotami* (in complete hecatombs) which have there been found. Twenty *tons* of these bones were shipped from around the one cave of San Ciro, near Palermo, within the first six months of exploiting them, and they were so fresh that they were sent to Marseilles to furnish animal charcoal for use in the sugar factories. How could this bone breccia have been accumulated? No predaceous animals could have brought together and left such a collection of bones, for though *Hyænæ* lived on the island, they have left no trace of their presence, nor marks of their teeth in this wonderful mass of bones, which would certainly not have escaped the animal's

[1] The Abbé Scinà, *Rapporto sulle Ossa Fossili di Mardolce*, Palermo, 1831; Dr. Christie, *Phil. Mag.* for Oct. 1831; Dr. Falconer, *Quart. Journ. Geo. Soc.*, vol. xvi., p. 99.

fangs. This breccia has been classed with the breccia of ordinary bone-caves, the former resort of predaceous animals, but the bones are *not gnawed*, as is the case with the bones in those caves, and besides they are the bones almost exclusively of *Hippopotami*, of which the remains are very rare in caves, as the weight of the animal must usually have led to its being devoured on the spot where it died. The only other suggestion that has been made is that the bones are those of successive generations of *Hippopotami* which went there to die. But this is not the habit of the animal, and besides, the bones are those of animals *of all ages down to the fœtus*, nor do they show traces of weathering or exposure.

The explanation which suggests itself to me is founded on the local topographical features of the island. The plain of Palermo is encircled by an amphitheatre of hills, rising to the height of 2,000 to 3,000 feet, and presenting mural precipices towards the plain. The caves are situated near the base of this escarpment, and at San Ciro the breccia not only subtends the cave, but extends to some distance on the slope *in front as well as on either side*. My supposition is, therefore, that when the island was submerged, the animals in the plain of Palermo naturally retreated, as the waters advanced, deeper into the amphitheatre of hills until they found themselves embayed, as in a seine, with promontories running out to sea on either side, and a mural precipice in front. As the area became more and more circumscribed the animals must have thronged together in vast multitudes,

crushing into the more accessible caves, and swarming over the ground at their entrance, until overtaken by the waters and destroyed. A few of the more agile animals may have escaped to higher unsubmerged ground, inland, for though the remains of *Deer*, *Ox*, *Bear*, and various *Felidæ* occur, they are exceedingly scarce; whereas the unwieldy *Hippopotami* perished in hundreds.

As the land afterwards emerged by intermittent stages, rocky *débris* and large blocks from the sides of the hills were hurled down by the current of water, crushing and smashing the bones, which are, with few exceptions, broken into thousands of fragments. I would account for the existence of such herds of *Hippopotami*[1] by the fact that after the formation of the Raised Beaches there was, as in the Channel, a considerable elevation of the coast, which led to a large increase of the land area: so that the plain of Palermo would then have been of greater extent, and the rivers much larger than at present. Judging from the habits of those animals and the extent of pasture grounds they must have required, the conjecture before referred to of a connection with Africa by the elevation of the Mediterranean area is rendered the more probable. This profusion of Hippopotami gives strength to the conjecture.

The extremely fresh condition of the bones, proved by the retention of so large a proportion of animal matter, and the fact that animals of all ages were

[1] Besides these animals which perished on the spot, many of their bodies may have floated away and been lost.

involved in the catastrophe, shows that the event was geologically, comparatively recent, as other facts show it to have been sudden.

Malta.[1]—The drift deposits of Malta present on the whole the same general features as those of Sicily, but owing to its peculiar population of *dwarf Elephants* with the *small Hippopotamus*, and the absence of the ordinary Quaternary Mammalia, the faunal remains have a distinct local colouring. They indicate that, like the Channel Islands, Malta had been isolated before the spread of the Rubble-drift; but, nevertheless, it is evident that it did not escape the catastrophe which affected the adjacent lands. On the south side of the island escarped rocks rise abruptly to the height of 200 to 300 feet. The lower part of these slopes is covered by a consolidated red breccia consisting of angular fragments of the adjacent rocks, mixed with the red earth covering the hill-tops. This breccia, which contains in places remains of the *pigmy Elephant*, I take to be the representative of the "*Head*" of the Channel coasts, only that in this instance the height of the escarpment has prevented its being entirely swamped and masked as were the old cliffs of the Channel. It resembles closely the breccia on the Mentone slopes, described at p. 36.

Besides the ordinary bone-caves several Ossiferous fissures, filled to the brim with red earth and angular rock-fragments, and containing remains of the same animals as those found in the caves, have been

[1] Admiral Spratt, *Quart. Journ. Geol. Soc.*, vol. xxiii. Dr. Leith Adams, *The Nile Valley and Malta*, p. 161.

discovered on the hills. Dr. Leith Adams notices the broken and splintered condition of the long bones, and mentions the fact that none of them were gnawed. He also makes the remark that "throughout the mass were strewn abundant remains of elephent bones with the teeth entire or broken together with fragments of bones of very large aquatic birds and those of the gigantic Dormouse, just as if numerous decayed carcases of elephants, large Water Birds and Rats scattered about on the surface, had been suddenly swept pell-mell into the gaping rent" with the detrital matter of the rocks. In the Shantiin fissure, upwards of fourteen elephant molars were discovered, while the Candia fissure was estimated to contain the remains of no fewer than sixteen individual elephants. The breccia is coloured by the red earth, and is generally cemented by carbonate of lime, like the Gibraltar and Nice breccias.

It is probable that Malta, no part of which exceeds a height of 800 feet, was entirely submerged, for not a single species nor even one genus of its Quaternary Mammalia are now living on the island, nor did any of its peculiar forms pass to the adjacent lands.[1]

The general relation of these deposits one to the other is shown in figure 6.

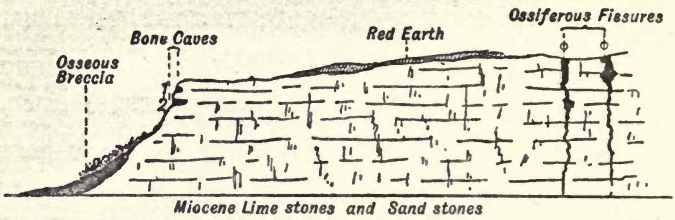
South-Eastern Europe and Greece.—We have referred to the extension of the high-level Loess over Central Europe. It extends also over Southern

[1] The Pigmy Elephant has recently been noted in Sicily.

Russia, and may possibly include the peculiar Black Earth or Tchernazem of those districts. Little has been recorded of the surface drifts in the Turkish territories, but what has been observed establishes the existence of Drift-beds generally and of a Raised Beach on the shores of the Bosphorus.

The rubble beds are largely developed in Greece, and are in places occasionally ossiferous. An angular

FIG. 6.—Diagram section on the south coast of Malta, showing the relative position of the Bone Caves, the Ossiferous Fissures and the Angular Breccia in slopes (Rubble-drift).



Over the osseous breccia is the recent cliff rubble.

rubble forms great sheets extending from the inland hills to the shore, where it is worn back into cliffs thirty to forty feet high, whilst the present torrents have cut through, and carry down the rubble *débris*, spreading it out on the coast in the form of cones of dejection, that are often re-cemented like the older breccia from which it is derived. At Mount Taygetus it rises on its slopes to the height of 150 feet or more. This Drift in the Morea is identical in many of its features with that of the South of England, and is I believe contemporaneous with it.

On the south coast of the Morea lies the island of Cerigo. At a short distance from the shore is a flat-

topped hill noted for the quantity of bones found in an Osseous breccia and in Ossiferous fissures. It was visited early in the century and briefly described by Spallanzani, and notwithstanding the evident interest of the place it does not appear to have been examined by any geologists since that time. He described the bones in the fissures as generally much broken and few entire and embedded in a reddish earth solidified. It was said by Cuvier closely to resemble the breccia of Nice.[1]

No description of the bones is given, but amongst them Spallanzani reports that the doctor of the island recognised a human jaw with its teeth and a portion of the skull with its sutures. Cuvier doubted the account, but without seeing the specimens, and it must be remembered that at that time it was the conviction both of geologists and naturalists that Man was of recent creation and had not existed at the same time as the great extinct Mammalia. The isolated position of the hill would, like those of Nice and Cette, cause its summit to be sought as a place of refuge from the rising waters, whether by the wild animals or by early Man.

Crete.—Not only are there in this island several raised beaches of Quaternary age, one of which is sixty-five feet above the sea level, but there is evidence that the movements of the ground have been continued down to recent times, for the west side of the island has been raised twenty-six feet within the historical period, whilst the east coast has subsided to

[1] See *Les Ossements Fossiles*, vol. iv., p. 213, Paris, 1823.

the extent of several feet. The two piers of the port of Phalasarna, a city of late Hellenic date, described by Strabo, are now twenty-two feet above their original level.[1] There are immense accumulations of angular detritus in the interior of the island, rising on the slopes up to the heights of 800 to 900 feet, and in one place, there is a calcareous *breccia overlying a Raised Beach* similar to those on the coast of the English Channel.[2] The surface is also largely covered with a red earth as in Greece.

Asia Minor.—There are traces of a Raised Beach in the Troad, but as it contains fragments of pottery, and exact particulars are wanting, it is probably of recent date. Elsewhere, the limestone cliffs are drilled by *Pholades* at a height of thirty-two feet above the sea level. There are also local detrital deposits derived from the neighbouring hills extending round the plain of Smyrna, some of which, M. Tchihatcheff says, may be of the same age as the Cave deposits. He adds that Quaternary deposits are much less common than in Europe.[3]

Cyprus.—There are remnants of a Raised Beach varying in height from three to thirty feet above the sea level round this island, with traces of Loess and a Rubble-drift, though in such small quantities as not to suggest any deep submergence, and this opinion is

[1] Admiral Spratt, *Travels and Researches in Crete*, 1865.

[2] Victor Raulin, *Description physique de l'Ile de Crète, partie Géologique*, pp. 616–656, 1861.

[3] *Asie Mineure*, 'Part 4, Géologie,' vol. iii., pp. 382–524, 1869.

confirmed by the absence of any Ossiferous Fissures, at least none are recorded.[1]

Syria.—Several Raised Beaches have been noticed on this coast, but I have not been able from the description of them to recognise anything in the shape of "*Head*"; unless it be the red loam in fissures and on slopes near Beyrout mentioned by Sir W. Dawson.[2] That during the late Quaternary period the district was inhabited by Pleistocene Mammalia, is manifest from the occurrence of the remains of *Felis spelæa*, *Ursus arctos*, *Rhinoceros tichorhinus*, *Bison priscus*, with those of *Deer*, *Horse*, *Wild Boar*, etc., in the few bone-caves of the district. Remains of Elephant and Hippopotamus have also been doubtfully alluded to.

M. Louis Lartet[3] speaks of a bone breccia with a few flint flakes near Tyre, and figures a palæolithic flint implement of a type common at Abbeville found near Bethlehem. Other specimens have been found in Arabia Petræa and Babylonia, but details of the sites and beds are wanting. Sufficient however has been made known to show that palæolithic Man, as well as the group of Pleistocene Mammalia associated with his remains in Europe, have been found in parts of Western Asia.

[1] Gaudry, 'Géologie de l'Ile de Chypre:' *Mém. Soc. Géo. de France*, 2nd Series, vol. vii., p. 149.

[2] *Egypt and Syria*, p. 155; and 'Notes on Prehistoric Man in Egypt and the Lebanon,' *Proc. Vict. Inst.* for May, 1884.

[3] *Géologie de la Palestine*, p. 224 *et seq.*, Paris, and 2nd t. p. 12.

Professor E. Hull [1] also mentions several Raised Beaches, probably of Quaternary age, varying in height from a little above the Mediterranean to an altitude of 200 feet; and Canon Tristram [2] has noticed some caves and detrital deposits. But none of these writers notice any of that Loess or of those Ossiferous fissures which constitute such marked features in the submerged area of Europe. Are we then to consider that at this Eastern end of the Mediterranean the submergence was of less importance? How far however it may have extended in a more north-easterly direction, we are wanting in exact evidence to decide.

The Coast of North Africa.—Here again we do not know the inland extent of the submerged area. On the coast we have clear evidence of the same character as that on the northern coasts of the Mediterranean. The whole of the north-western coast was subject during the Quaternary period to repeated elevatory movements, for traces of Raised Beaches of that age exist at various elevations from 5 feet to 600 feet, like those on the high Rock of Gibraltar with which they were no doubt contemporaneous. It is rarely that the few shells found in the higher beaches are described, but in one instance we are informed that specimens of *Pecten opercularis, Pectunculus glycimeris, Cardium edule, Venus gallica, Turbo rugosus,* and *Fusus corneus,* all common recent Mediterranean and Quaternary

[1] *The Geology of Western Palestine.*

[2] *The Land of Israel.*

species, were found at a height of about 400 feet above the present level of the Mediterranean. This shows at all events that, at the time the higher of these beaches were formed, the depression was such as must have led to the inroad of the sea to a considerable distance inland, but how far we cannot say. In any case the difference of level is such that a very broad belt of the coast line must have been covered by the sea,[1] at the same time that the Strait of Gibraltar must have been materially widened, and its depth diminished.

At Tangier there is a well defined Raised Beach[2] about forty feet high, in which there was found a tooth of *Elephas antiquus*. Near Tetuan there are some large fissures, the breccia in which contains both animal remains and land shells—chiefly *Helices*.

Algeria.—At Oran[3] there is a Raised Beach about twenty feet above the sea level, with abundance of shells, mostly of species still living in the Mediterranean, and above this there is a *breccia of angular fragments of slate and limestone*, so that we have here an exact counterpart of the Raised Beaches and *Head* of the channel. The limestone rocks are likewise traversed by large fissures filled with a breccia, containing bones of *Bear*, *Ox*, *Horse*, *Deer*, &c. It is said to present precisely the same characters as the ossifer-

[1] This was anterior to the time of the Rubble-drift.

[2] Maw, *Geol. Mag.*, vol. vii., p. 548 ; Ramsay and Geikie, *Quart. Jour. Geo. Soc.*, vol. xxxiv., p. 514.

[3] Bull, *Soc. Géol. de France*, 2nd Ser., vol. xi., p. 505 ; Desnoyers in Ch. D'Arbigny's *Dictionnaire d'Histoire Naturelle*, vol. vi., p. 383.

ous breccia of Nice and Gibraltar.[1] It is also said that there are traces of a detrital drift inland, but no particulars are given.

Similar features are observable all along the coast of Algeria, with the addition of some bone-caves, but one at least of these latter, although called a cave, seems to have been more like an Ossiferous fissure. In the red breccia, which partly filled it, besides the mammalian bones, a *worked flint flake* was found, and, in another instance, a *human molar tooth.* The animal remains in these several caves belonged to *Hyæna, Rhinoceros, Felis, Ox, Antelope,* &c., but the species are not named; they were however said to differ from existing species. Palæolithic flint Implements[2] of the ordinary type have also been met with, but they were on the surface.

Constantine, Tunis, Tripoli.—No caves nor Ossiferous fissures have, that I am aware of, been recorded in these provinces; but a breccia of uncertain relations, with large blocks, has been noted, together with a Raised Beach. Further eastward the country is described as consisting of rolling hills of Cretaceous age in a sea of Quaternary drift of reddish loam with a few land shells—especially the *Zonites Candidissimus*—a species still common in the district. This deposit appears to range into Tripoli and towards the Lybian desert.

There is apparently no evidence of the submergence having extended in this direction beyond these limits.

[1] Desnoyers, *op. cit.*, p. 383.

[2] Sir John Lubbock, *Journ. Anthrop. Inst.*, vol. x., p. 216.

There have been oscillations of the land, but no submergence such as would appear to be indicated by the several forms of the Rubble-drift.

Egypt.—Though there are Raised Beaches and high-level river terraces in Egypt showing considerable changes of level, there is no distinct evidence of the country having been submerged at the period in question. Had any such evidence existed, it could hardly have escaped the notice of the many geologists who have explored that country. The long lines of limestone escarpments, and the great extent of sections exposed in quarries, could hardly have failed to have revealed such conspicuous objects as Ossiferous fissures and Osseous breccias had there been any. One of the higher Raised Beaches was found by Sir J. W. Dawson on the Mokattan hill, near Cairo, at a height of about 200 ft. above the sea-level. It contained species of *Ostrea*, *Pecten*, *Terebratula*, *Lithodomus*, and *Balanus*.[1]

The old river terraces above Assouan are about 120 ft. above the level of the Nile. Dr. Leith Adams states[2] that they contain several species of freshwater shells, and amongst them the *Corbicula* (*Cyrena*) *fluminalis* so common in pre-glacial and post-glacial times in England, but now confined to Thibet and some other parts of Asia.

Nor have any of the deep borings[3] made of late

[1] *Syria and Egypt*, Chapters ii. and iv.

[2] *The Nile Valley and Malta*, pp. 161–238.

[3] Leonard Horner, *Phil. Trans.* for 1855 and 1858; Prof. Judd, *Proc. Roy. Soc.* for 1885, p. 213.

years in the Nile Valley met with a drift that might represent the rubble-bed that underlies the Alluvium of the valleys of Western Europe.

Nevertheless, judging by analogy, it would appear that Palæolithic Man did inhabit the Nile Valley, for flint or chert implements of the precise type of those found in the river drifts of the Thames and Somme Valleys have been discovered there by Sir John Lubbock, Prof. Haynes, and Mr. F. N. Flinders Petrie, but they were all on the surface and nothing is known of the beds from which they may have been derived.[1] Possibly, they may be specimens originally dropped or lost on the surface, or embedded in some old fluviatile drift. The sand-worn condition of one side of one of the specimens shows it to have been long exposed to drifting sand-storms.

Another circumstance tending to show that Egypt has not been submerged since the Palæolithic period is that several of the animals which lived in Western Europe and North-Western Africa before the time of the Rubble-drift disappeared in those areas after that event, whereas they survived in the Nile Valley to Historic times; such for example are:—

Lion.	*Spotted Hyæna.*	*Hippopotamus.*
Panther.	*Caffir Cat.*	*African Elephant.*

This may be merely a coincidence, but it seems to me to have a collateral bearing on the question, and to afford, with the other facts named, grounds for

[1] Palæolithic Man in Egypt may have preceded his appearance in Europe.

supposing that the submergence did not extend to Egypt. On this point, however, I would speak with all reserve.

§ 8.—Concluding Remarks.

A preliminary objection to a submergence of the character described in the foregoing pages, that will no doubt occur to many, must not be passed over in silence. I allude to the entire absence of marine remains in the different phases of the Rubble-drift over the area supposed to have been submerged. In reply it has to be observed that for marine remains to have been located on the submerged land, certain conditions would be indispensable. In the absence of those conditions, we could not expect to meet with such remains. 'It is not to be assumed, because the waters of the sea have for a time covered the land, that marine remains should be found there. If the submergence were slow, the advance of the waters would not have force sufficient to carry before them any of the objects on the shore; or, if any living object were so floated, the turbidity and deoxidised state of the waters resulting from the uprooting of the surface soil with its vegetable matter would be fatal to animal life, and their remains, if any, would decay on the surface and be lost.

But it may be asked, why after the submergence, and before the return upward movement, should not the fauna from adjacent undisturbed areas have

migrated on to the submerged land surface? This would no doubt have taken place had the submergence been of long duration; but, short as the general evidence leads us to suppose it to have been, such a migration was not possible. The muddy state of the waters would also for the time be a hindrance to the existence of animal life.

The *physical evidence* is to the effect that the advancing waters had little erosive power, since they failed to destroy the Beaches over which they passed, or to wash away the dunes or blown sands which overlie the Raised Beaches on the north coast of Devon and Cornwall. At the same time, the advance of the waters was progressive, as, had they been long stayed, they would not only have destroyed these surface features, but would have left their mark on the land surface, either in the form of a beach, or by a line of water-erosion on the rocks at the level at which they remained for the time stationary. The inference is that the waters rose slowly and continuously, charged merely with the mass of sediment derived from the soil and rocks over which they passed. This sediment, which was deposited either at the high tide of the waters or at intervals as they subsided, forms the mantle of *Loess* so conspicuous in Central Europe, and of the slighter deposit of *red earth* so widely spread on the lands bordering the Mediterranean.

That there was but a short lull when the submergence reached this stage is to be inferred from the fact that the Rubble-drift rests immediately on the

Raised Beach. Had there been any long interval, there would have been some form of sedimentary deposit between the Beach and the *Head* or the blown sands; but there is none. With the commencement of the elevatory movement, effluent currents at once came into play, and, according to their varying velocity, carried down, sometimes the surface soil or the freshly deposited Loess, and at others the coarse surface detritus. The conclusion from this is that the upheaval was by fits and starts, or rather by a continuous movement, sometimes very slow and at others more or less rapid, and ending with one of greater rapidity. Where hollows or cavities existed on the surface, the *débris* fell into them. Open fissures were filled to the brim by the passing *débris*, while the current, acting as a broom, brushed off any projecting *débris* on the top of the fissures, and at the same time swept bare the adjacent more exposed surfaces.

We judge from these conditions that the submergence took place slowly and continuously. I do not mean by slow, that it took years, but so slow possibly as on the whole to be hardly apparent to the spectator of the scene, or, may be, it would give him the reverse impression, such as that experienced when one's own train at a railway station makes a noiseless start and another train is standing still alongside, that that train was moving and your own stationary or *vice versâ*. So, in this case, the land would seem to one standing on it, as though it were immovable

and stationary, and that it was the waters that were in movement and rising.

The evidence of the Organic Remains is to the same effect. The old River-drifts such as those of the Thames Valley, and some older detrital beds, such as the Red Crag of Suffolk, occasionally contain the bones of animals, which, if sometimes whole, are generally *rolled and worn*, though not gnawed. Animal remains are also common in caves of the same age as the River-drifts, but these are *broken and gnawed*, showing them to have been carried there to be devoured by predaceous animals. Sometimes the long bones have been brought in by Palæolithic Man, in which case they are generally split longitudinally for the purpose of getting at the marrow. Such are the conditions of the bones in the deposits of which the origin is known.

On the other hand, the bones found in the Osseous Rubble, the *Head*, and Ossiferous Fissures, are invariably not merely broken but mostly splintered into hundreds of fragments, which, as a rule, retain their sharp angles. They are *neither weathered, worn, nor gnawed*. This condition therefore is in direct discordance with that which obtains in the other known Drifts. The agency, whatsoever it was, must have acted with sufficient violence to smash the bones, but without the prolonged action which would have worn them. Such a result might well have ensued from the successive falls of masses of rubble over the old cliffs or into deep fissures, as would happen whenever the uplift was rapid enough to give rise to a strong

current. At other times, the currents being slight were only sufficient to wash down the finer sediments and the small fragile land shells without destroying them. In the few rare cases where marine or fluviatile shells occur, they have been derived from some submerged shore or river. All the organic remains proper belong to the same geological period—that is to say, to the late Quaternary or Pleistocene, though they show that variation in the distribution of species which marks, as at present, the influence of climate, soil, and altitude.

Not only have the several forms of the Rubble-drift an origin due to a common cause, but the unity of the whole of the phenomena is further evinced by the synchronism of the rents in the rocks with the ossiferous breccia lodged in them. Had these fissures been open at a period anterior to the Rubble-drift the lower stratum of animal remains must have belonged to an older fauna, and the breccia would have been of a less homogeneous character. There would have been successive layers in accordance with differences of age and conditions. There is however no evidence to show that the fissures were open at any previous period, but on the contrary, much to show that their formation was the result of the one set of land movements. At the present day, it is common for fissures in the ground to open during earthquake movements, but they generally soon close again. In this case we have reason to suppose that the fissures were so speedily filled during re-elevation of the land, that they were prevented from closing, and thus re-

main as monuments of the strains that accompanied the great earth movement. I conclude, therefore, that the dispersion of the surface *débris*, the formation of the Ossiferous fissures, the accumulation of the "*Head*," and the local ablations of the rocks, are the necessary results of the Submergence and subsequent Re-elevation of the land.

§ 9. Date of the Submergence.

We are here confronted with very contradictory opinions. The doctrine of Uniformity leads to such extreme demands on time that Croll's hypothesis, which in that respect is in harmony with those views, has been very generally adopted. According to Croll's last estimate, the Glacial Period commenced 240,000 years and ended with the Post-glacial 80,000 years ago. The latter date was supposed to correspond with the close of the Pleistocene and Palæolithic period. It followed on this assumption that a vast interval of time must have intervened between that period and the Neolithic times. Were that the case, there ought to be some geological evidence either in the form of sedimentary deposits, or of work done in the excavation of valleys; I fail to find either. So far from there having been a vast interval of time between the Palæolithic and Neolithic periods, the stratigraphical evidence shows that they follow quickly in immediate succession. The deposits of the two periods are in fact separated merely by a few feet (and that only in places) of Rubble-drift from one

another, and this drift is, as I have before explained, a detrital bed requiring but a short time for its formation.

If then the lapse of time since the formation of this detrital bed were known, we might hope to arrive at some conception of the approximate date of the Submergence, and of the time which separates Recent from Palæolithic Man. In this country two scales may possibly prove available—the one is that afforded by the Alluvial beds of such valleys as those of the Thames and others in the south of England; and the other by the extent of denudation or wearing back of the Rubble-drift of the "Head" that has taken place on the coast since it was formed. With respect to the Alluvial deposits, though their structure and organic remains indicate their recent origin and comparatively rapid growth, their thickness is so variable, and the rate of growth of the peat-beds so uncertain, that a wide range must be allowed. We know that within Neolithic times there has been in places a growth of ten to eighty feet of these deposits. The skeleton of recent Man at Tilbury was found under thirty-four feet of clay and peat. In the Valley of the Somme, Gallo-Roman remains have been found under a depth of eighteen feet of peat. As however the thickness of these beds rarely exceeds about 100 feet, and is generally limited to twenty to forty feet, it is manifest, although we cannot define the period with exactness, that the age of the Alluvial beds is to be measured, not by tens of thousands, but by tens of hundreds of years.

The extent of denudation that the "Head," where it forms a cliff, has undergone by the action of the sea, offers a better chronometrical scale. Though here again exact measures are yet wanting, we can form some idea of what may be the limits it indicates. The old (*raised*) line of coast, as it existed before the spread of the Rubble-drift, differs but little from that of the existing line, so that, if the extent of the retrocession of the coast-line since the Submergence which originated the "Head" could be determined, we might, knowing the present rate of wear of the cliffs, arrive at some approximate idea of the time that has elapsed since the erosion of the existing line of cliffs commenced. Judging from an estimate I made,[1] the loss of land on the south coast in the districts occupied by soft Cretaceous, Oolitic, and Liassic strata, since the date of the Rubble-drift, amounts, at the extreme, to about four miles; but generally it is limited to a breadth of one to two miles or less. Taking the present known rate of the wearing back of the cliffs at from one to three feet annually, this would bring the total loss roughly within the limits of 6,000 to 12,000 years. (See Fig. 1, p. 22.)

On the south-west coast composed of hard Palæozoic rocks, the extent of wear of the land has been comparatively trifling. No exact measure has yet been made of what the rate of wear is at present. That it is exceedingly slow is evident from the cir-

[1] *Quart. Journ. Geol. Soc.*, Vol. xlviii., p. 264, and Pl. viii.

cumstance that, on the coasts of Devon and Cornwall, the present coast line hugs the old line of Raised Beach and "Head" very closely, the two being seemingly in no instance distant more than a quarter of a mile apart.[1] In fact, the distance apart does not usually exceed 50 to 500 feet, so that the time-estimate would, no doubt, be well covered by the term I have allowed for the wear of the south coast. Although these findings cannot pretend to the accuracy required, they confirm the other evidence; and the plan may serve as a basis for more exact calculation. In any case, these tentative estimates are in accordance with the conclusion I had arrived at on other grounds, that the Glacial (including the post-glacial) period, together with Palæolithic Man, came within 10,000 to 12,000 years of our own times.

I cannot conclude without referring to the opinion of some of the most eminent American geologists, founded on independent data of a different character from that which we have considered in these pages,—namely that the Glacial period came down to within 8,000 to 10,000 years of our times.[2]

[1] On these coasts there is another scale which might be made available. Some early British camps or enclosed earthworks, situated near the edge of the cliffs, have, owing to the encroachment of the sea, been in part destroyed. It would not be difficult, where these are near a Raised Beach, to determine the extent of loss; and as the date of the earthworks could be approximately ascertained, this, with a few years' observation of the present rate of wear, would furnish further data for time-measurement.

[2] This was my original opinion, which subsequent observation has confirmed (*Proc. Royal Institution* for Feb. 26, 1864).

§ 10. The Bearing of the Submergence on the Tradition of the Flood.

In reviewing the phenomena which we have described we cannot escape noticing the analogy which many of the facts present with some of the main physical events recorded in the narrative of the Flood, whether in the Biblical or the Babylonian version. There is the same gradual rise of the waters, for to those peoples who witnessed the event the slow land-movement would not, as we have already pointed out, be apparent, and they would only be conscious of the gradual encroachment of the waters over the land inhabited by them.

There is the same wide-spread though, on our hypothesis, only partial and local destruction of life, the higher hills and mountain summits beyond reach of the flood having served as places of refuge for the life that survived the catastrophe; and from those centres the land was re-peopled after its re-elevation.

Other phenomena have led us likewise to suppose that the Submergence was transient or of short duration, as there is an absence of all the consequences that would follow on a long submersion.

That Man lived at the time is now a question not necessary to argue, since the fact of the existence of (Palæolithic) Man over the whole of the area we have described is, at the present day, a well-established fact. Therefore, as the dispersion of the Rubble-drift took place at the close of the Quater-

nary period, that certain communities of early Man must have suffered in the general catastrophe may be taken for granted. At the same time, although portions of the perishable *human* skeleton have been found in Quaternary bone-caves and in the high-level Loess, it is chiefly by his indestructible stone tools and weapons that the extended presence of Man in the Quaternary period has been revealed. Flint implements fashioned by the hand of Man have been discovered in the Rubble-drift at Portslade, near Brighton, at Sangatte, Mentone, Algeria, and other places. Little systematic search has, however, yet been made, and the field is a new one. That local populations were spread over Western Europe and along the shores of the Mediterranean at a time anterior to the Rubble-drift, the cave and rock-shelter evidence renders certain. Owing, however, to the perishable nature of his remains, and to the fact that Man knew better how to avoid the threatened danger, his remains are rare in comparison with those of the contemporary animals. It must also be remembered, in considering the great disproportion in their respective remains, that at that time there were but few men compared with the thousands of animals to be affected by the event. What are now the sparse tribal settlements compared to the innumerable herds of animals spread over the boundless plains of Africa?

Another cause has been assigned for the tradition of the Flood, but it appears to me inadequate. The valley of the Euphrates, like that of the Nile, is subject to

periodic inundations dependent upon the annual melting of the snow on the mountains at its sources; and it has been suggested that, in a year of excessive snow thawing or rainfall, an inundation of exceptional extent might have taken place and given rise to the tradition. But there is no record of such floods in recent or historical times, and neither Ainsworth nor Dr. Rauwolff, who visited the country in 1573, make mention of any. Mr. Loftus tells us that at Bagdad the ordinary annual rise of the river is 17½ feet, though in 1849 it rose to 22½ feet, which was considered extraordinary.[1]

Moreover, in valleys subject to annual floods, the inhabitants, aware of their danger, avoid the lower lands, and build on ground well above the reach of the waters, so that the floods could never be so disastrous as in river-valleys where their occurrence is exceptional. In the Euphrates Valley, the towns and villages are as a rule all on rising ground or hills. Besides, in the Babylonian account of the Flood, it is stated that it covered the whole of the land with the exception of the highest hills. Allowing for the figurative character of the expression, this is a circumstance highly improbable if not impossible to have happened as the result of a river-flood.

We must therefore look for some other cause to account for the tradition; and considering the close agreement indicated by the geological phenomena

[1] Loftus, *Quart. Journ. Geol. Soc.*, Vol. xi., p. 250. The mud deposit on the banks at Bagdad attained a depth of six feet. There was another great flood in 1831.

with the main physical facts mentioned in the narrative, no explanation seems to me so probable as the hypothesis I have ventured to put forward. River-floods, howsoever devastating, as for example those of the Yellow River, make no lasting impression on a busy and rude population, and are soon forgotten; but a Submergence of the vast extent described would be not only in accordance with the magnitude of the recorded catastrophe, but, having also been looked upon as miraculous and in a religious aspect, would account for the deeper and more lasting impression produced on those peoples who had at the time cognisance of the disaster. Nor would it accord less well with the remoteness of the event, the dimness of the tradition, and the growth of its allegorical accompaniments.

APPENDIXES

APPENDIX A

P. 3. The following extracts from the Babylonian version of the "Deluge," given by the Rev. Professor Sayce in his *Fresh Light from the Ancient Monuments* (p. 28, 1892), will show the points of difference with the Hebrew version.[1] The translation is that of Professor Haupt.

"Sisuthros" (or Khasiadra—the Chaldean Noah) "speaks to him, even to Gisdhubar: Let me reveal unto thee, Gisdhubar, the story of my preservation, and the oracle of the gods let me tell to thee. The city of Surippak, the city which, as thou knowest, is built on the Euphrates, this city was already ancient when the gods within it set their hearts to bring on a deluge, even the great gods as many as there are. . . . . Ea, the lord of wisdom, sat along with them, and repeated their decree: 'For their boat! . . . . . O man of Surippak, son of Ubara-Tutu; dig up the house, build the ship, save what thou canst of the germ of life. (The gods) will destroy the seed of life, but do thou live, and bid the seed of life of every kind mount into the midst of the ship. The ship which thou shalt build. . . . . (But as for thee) shut (not) the door (until) the time comes of which I will send thee word. (Then) enter the door of the ship, and bring into the midst of it thy corn, thy property, and thy goods, thy family, thy household, thy concubines, and the sons of the people. The cattle of the field, the wild beasts of the field, as many as I would preserve, I will send unto thee.' . . . . . .

[1] In a later work (*The Higher Criticism*, 1894) Prof. Sayce gives a somewhat fuller account of the Babylonian version, but it does not alter the essential points named here.

"(With the help) of Samas (the Sun-god) the compacting of the ship was finished; (all parts of the ship) were made strong, and I caused the tackling to be carried above and below. (Then of my household) went two-thirds: all that I had I heaped together; all that I had of silver I heaped together; all that I had of gold I heaped together; all that I had of the seed of life I heaped together. I brought the whole up into the ship; all my slaves and concubines, the cattle of the field, the beasts of the field, the sons of the people, all of them did I bring up. The season Samas fixed, and he spake, saying: 'In the night will I cause the heaven to rain destruction. Enter into the midst of the ship and close thy door.' . . . . . I entered into the midst of the ship and shut the door, that I might close the ship. To Buzur-sadi-rabi, the boatman, I gave the palace with all its goods. Then arose Mu-seri-ina-namari [The Water of Dawn at Daylight] from the horizon of heaven (like) a black cloud. Rimmon in the midst of it thundered, and Nebo and the Wind-God go in front; the throne-bearers go over mountain and plain; Nergal the mighty removes the wicked; Adar goes overthrowing all before him. The spirits of earth carried the flood: in their terribleness they sweep through the land; the deluge of Rimmon reaches unto heaven; all that was light to (darkness) was turned. . . . . .

"(The surface) of the land like (fire?) they wasted; (they destroyed all) life from the face of the land; to battle against men they brought (the waters). Brother saw not his brother; men knew not one another. In heaven the gods feared the flood, and sought a refuge; they ascended to the heaven of Anu. . . . . Six days and nights the wind, the flood, and the storm go on overwhelming. The seventh day when it approached the storm subsided; the flood which had fought against (men) like an armed host was quieted. The sea began to dry, and the wind and the flood ended. I watched the sea making a noise, and the whole of mankind was turned to clay; like reeds the corpses floated. I opened the window, and the light smote upon my face; I stooped and sat down; I weep; over my face flow tears. I watch the regions at the edge of the sea; a district rose twelve measures high. To the land of Nizir steered the ship; in the mountain of Nizir stopped the ship, and it was not able to pass over it. The first day, the second day, the mountain of Nizir stopped the ship. The third day, the fourth day, the mountain

of Nizir stopped the ship. The fifth day, the sixth day, the mountain of Nizir stopped the ship. The seventh day when it approached I sent forth a dove, and it left. The dove went and returned, and found no resting-place, and it came back. Then I sent forth a swallow, and it left. The swallow went and returned and found no resting-place, and it came back. I sent forth a raven, and it left. The raven went and saw the carrion on the water, and it ate, it swam, it wandered away; it did not return. I sent (the animals) forth to the four winds, I sacrificed a sacrifice. I built an altar on the peak of the mountain. I set vessels [each containing the third of an ephah] by sevens; underneath them I spread reeds, pinewood, and spices. The gods smelt the savour; the gods smelt the good savour; the gods gathered like flies over the sacrifices. Thereupon the great goddess at her approach lighted up the rainbow which Anu had created according to his glory. The crystal brilliance of those gods before me may I not forget.". . . . . .

Prof. Sayce goes on to say that "The land of Nizir, in which the vessel of Sisuthros rested, was among the mountains of Pir Mam, to the north-east of Babylonia." A widespread Eastern tradition makes Gebel Gudi or Mount Gudi on the boundary between Armenia and Kurdistan, the mountain on which the Ark rested. The mountains of Ararat might have been the Kurdish ranges of Southern Armenia.

The peculiar value of the Babylonian Tablets consists in their having preserved the uncorrupted Accadian or Chaldean version of the Deluge. The tradition however survived in all its main points, though with variations, in the countries round Armenia and in the Euphrates Valley, whence it passed into Greece under the designation of the Deluge of Deucalion. Lucian in his work *De Deâ Syriâ*, after recording the tradition that the former race of man was doomed to destruction on account of its wickedness, and was destroyed by a flood which covered the whole earth, proceeds to say that Deucalion alone was preserved to re-people the world, and that "His preservation was effected in this manner. He put all his family, both his sons and their wives, into a vast ark, which he had provided; and he went into it himself. At the same time animals of every species, *boars*,

horses, lions, serpents, whatever lived upon the face of the earth, followed him by pairs; all which he received into the ark and experienced no evil from them." It was further said that he "sent out a dove from the ark, whose return indicated a continuance of the deluge; but its neglect to return, when sent out the second time, or, as some say, its return with muddy feet, showed that the waters had disappeared." Professor Hitchcock however remarks on this that Lucian "was a native of Samosata, on the banks of the Euphrates; and although he professes to give the Grecian account, it would be strange if he had not added some circumstances, which he doubtless learnt in early life in his native place," where tradition of a great deluge existed.[1]

Again he tells us that "The tradition of the Assyrians on this subject appears from a passage quoted by Eusebius from Abydenus. 'After whom others reigned, and then Sisithrus; to whom Saturn foretold that there should be a great flood of waters, (or many showers), upon the fifteenth day of the month Desius; and ordered him to hide whatever writings he could find, in Heliopolis, a city of the Sippari. Sisithrus, having performed this, immediately sailed towards Armenia; and instantly after, those things which God had foretold came to pass. And on the third day, when the tempest was ceased, he made a trial by sending out birds, to see if they could espy any land uncovered of water. But they finding nothing but the immense ocean, and not knowing which way to direct themselves, returned to Sisithrus; and after these he sent out others; that the third time it answered, for the birds returned with their feet all mudded. But as for Sisithrus, the gods took him from among men. And the ship was carried to Armenia.'" . . . . . .

[1] *The Historical and Geological Deluge Compared.* By Prof. E. Hitchcock, Amherst College, U.S.A. Edinburgh, 1837.

APPENDIX B.

P. 5. The measure here named has greatly impeded free inquiry on questions relating to geological chronology. The subject is too long and too intricate for discussion here, but I must demur to inquiry being stayed by a barrier based upon a doctrine so questionable on physical grounds as that of Uniformity of action both *in kind and degree* in all past time. To assume that the present slow movements of the crust of the earth give the rate of movement for the long past seems to me to involve a physical impossibility as great as that of a universal deluge. The forces now acting upon the crust are in a state of comparative equilibrium. But even now there are instances of sudden elevatory movements of a few feet, as for example on the west coast of South America of four or five feet, and more lately of a fault of twenty feet formed in a single night in Japan. Which of these three rates are we to adopt? or rather is it possible to accept any of them as a measure of geological time? or if any, it certainly should be the maximum. Are we to ignore the major and accept a minor quantity?

If we could suppose that the causes which produced the movements of the earth's crust had always acted with the same *degree* of energy, the reasoning of the Uniformitarians would hold good; but as that regularity depends upon the stresses to which the earth's crust has been exposed at any particular time, the effects must have varied in proportion as the stresses varied. With a gradually cooling globe it could not have been otherwise. What those movements of the past were, and what their direction, must be judged of by other circumstances and on surer data.[1]

[1] I have discussed this question at some length in a paper "On the Position of Geology," published in the *Nineteenth Century Magazine* for October, 1893, and re-published in my *Collected Papers on Controverted Questions of Geology*, 1895.

APPENDIX C.

P. 27. The following are the main points relied on in the explanations that have been suggested to account for the origin of the "Head," together with some of the objections to them.

1. That the *Head* is due to excessive rainfall. The absence of water channels and of water-worn materials are objections to this view.

2. That, during the Glacial period, ice and snow sliding down the surface of the hills carried with them the surface *dêbris* which it deposited at lower levels. This is open to fewer objections, but the gradients are in general too small, and it fails to account for the condition of the organic remains; and it is difficult to conceive that a surface thus planed off should afford sustenance to the class of animals and molluscs found in the rubble; nor have the proposers of this explanation given any instance in which the same general conditions obtain in cold or arctic districts at the present day.

3. A wave of translation, such as suggested by Sir Roderick Murchison, also fails to embrace many of the observed results, though it accords with the angularity of the *dêbris*.

4. To severe cold and fluviatile agency; but there is no evidence of river action, no wear by rolling, no concordance with the topographical conditions,[1] and no fluviatile remains.

APPENDIX D.

P. 33. The Somme district affords excellent illustrations of the successive stages of the valley drift deposits ending with the Rubble-drift and Alluvial beds; we there find—

First and oldest.—The high-level gravel of St. Acheul, Amiens,

[1] The objections are more fully stated in my paper on "Raised Beaches," *Quart. Journ. Geol. Soc.*, Vol. xlviii., pp. 326–328.

with its mammalian remains, and abundance of Palæolithic flint implements, mostly of the spear-head type.

Secondly.—The low-level gravel of Montiers (Amiens) and of Menchecourt (Abbeville) with the *Corbicula fluminalis*, mammalian remains and Palæolithic flint implements of somewhat though slightly different types. This rests at the last-named place upon an estuarine shelly bed, the equivalent of the Raised Beach on the coast. To these succeed well-developed fluviatile beds.

Thirdly.—The Rubble-drift sweeps down from heights above Abbeville and covers all the preceding beds unconformably, carrying with it *land-shells* and some Palæolithic implements; it then passes down to and is lost under the Alluvial deposits of the valley.

Lastly.—The Alluvial deposits which overlie the trail of the Rubble-drift, and are continuous from the Neolithic to the present times.

APPENDIX E.

Note p. 35. The animal remains found in the Quaternary deposits in the Belgian Caves are, according to M. Dupont, those of *Lion, Spotted Hyæna, Lynx, Wolf, Fox, Wild Cat, Polecat, Cave Bear, Grisly Bear, Brown Bear, Wild Boar, Mammoth, Tichorhine Rhinoceros, Hippopotamus, Beaver, Glutton, Otter, Reindeer, Megaceros, Red Deer, Saiga Antelope, Elk, Chamois, Goat, Marmot, Hamster, Eland, Roebuck, Aurochs, Bison, Horse, Hare, Squirrel, Water Rat, Mouse, Lemming, Badger, Weasel, Ermine, Hedgehog;* and of *Birds* he mentions *Blackcock, Duck, Crow, Thrush,* together with a few *Batrachians* and river *Fishes,* and objects in flint and bone worked by Palæolithic Man.

The remains of Neolithic age are less easily determined, as they seem to be in some cases included with the older species. To take however one instance, about which there can be no doubt, as Human Remains were found with pottery and objects in flint

and stone implements of neolithic age. With these M. Dupont found associated bones of *Wild Boar*, *Horse*, *Reindeer*, *Red Deer*, *Roebuck*, *Chamois*, *Bison*, *Ox*, *Goat*, *Bear*, *Dog*, *Wolf*, *Fox*, *Polecat*, *Lemming*, *Water Rat*, *Mouse*, *Hamster*, *Lagomys*, *Mole*, *Hedgehog*, *Beaver*, *Martin*, *Weasel;* of birds, *Owl*, *Jay*, *Magpie*, *Thrush*, *Pigeon*, *Grouse*, *Partridge*, *Blackcock*, *Duck*, *Goose;* with *Batrachian* and *Snake* remains, and *land-shells*.

APPENDIX F.

P. 40. Several theories have been proposed to account for the wide spread of the *Loess*; the principal of these attribute its formation:—1. To a depression of Central Europe whereby the gradient of the upper valleys was so greatly reduced as to cause them to be flooded, while no change of level occurred nearer the sea.[1] 2. To the advance of the great northern ice-sheet, blocking the large rivers of Central Europe, and damming back their waters, and so flooding wide tracts of land.[2] 3. To high winds acting upon soft or disintegrated rock-surfaces.[3] There are various objections, which I have elsewhere specified, to these different opinions.[4]

There is nothing to corroborate the suggestion of a great central depression which at the assumed rate of five feet in a century (the rate adopted in this case) would have required a period of not less than 40,000 years and should have left substantial marks of subaqueous work effected in that length of time. With regard to the second suggestion, it would have required an ice-dam all round the central area, whereas the ice-dam would only have affected the northern outlets. Nor could any local river ice-dam have sufficed to inundate so wide an area and such great heights.

[1] Lyell, *Antiquity of Man*, p. 383.
[2] Belt, *Quart. Journ Geol. Soc.*, Vol. xxx., p. 490.
[3] Richthofen, *Geol. Mag.* for 1882, p. 293.
[4] *Phil. Trans.*, Vol. clxxxiv., pp. 919–923.

Baron von Richthofen has shown that in China an enormous accumulation of a Loess-like deposit has been formed by dust storms caused by devastating winds, and that this deposit extends from the sea-level up to heights of 8,000 ft. or more, whilst it attains in places a thickness of 1,000 to 1,500 ft.; whereas the Loess in Europe is clearly water-deposited and is rarely more than 100 ft. thick. The skeletons also of the animals buried by the dust storms must be in most cases preserved entire and not in the fragmentary state in which they occur in the Loess of Europe.

APPENDIX G.

P. 43. The discovery is not altogether new, for in five analyses of the Belgian Loess by Kane in 1846, a small proportion of chloride of sodium was found in each case. Payen also has shown that one of the soils in Russia (? Loess) contains a notable proportion (1·21 per cent.) of alkaline chlorides; and in an analysis by the same chemist quoted by Bischof of the Black Earth of Southern Russia, which is possibly only a variety of Loess, there appears as much as 1·32 per cent. of an alkaline chloride. But in all these cases the geological particulars are insufficient to determine the exact position of the bed analysed.

The statements, however, of M. Stainier give definite information, both as to the localities where the specimens were obtained and the fossils, and it will be easy to determine the exact division of the Loess at those places. The bed is evidently one of an argillaceous character, as it contains 37·71 per cent. of clay, and is so impermeable that the rain-water runs off its surface, so that the salt is not washed out of it as would be the case in other more permeable beds of Loess. Four analyses of the Loess in the Valley of the Rhine (Bischof) show a mean of only 10·17 per cent. of clay. This inquiry should be extended to the great deposit of high-level Loess in Central Europe.

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